Biom'@x

Sciences et technologies:
towards a technological translational medicine

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femto-st
SCIENCES &
TECHNOLOGIES


cnrs


UBFC
UNIVERSITÉ
BOURGOGNE FRANCHE-COMTÉ


UNIVERSITÉ DE
FRANCHE-COMTÉ


ensmm
École Nationale Supérieure de
Mécanique et des Microtechniques


utbm
université de technologie
Belfort-Montbéliard

FEMTO-ST is a public research institute located in the Bourgogne Franche-Comté region, east of France, next to Switzerland and Germany.

The general aim of the FEMTO-ST institute is to master micro and nanotechnologies, develop new devices and systems, optimise the performances, find new functions for them ans make them «smart».

It is organized in 7 scientific departments (robotics & automation, digital information science, energy, applied mechanics, micro-nano-sciences and systems, optics, RF and microwave metrology), with an average number of collaborators of about 750 members (PhD students, postdocs, technicians, engineers, administrative staff, researchers and professors).

FEMTO-ST members are essentially employed by four different French public research and higher education institutions: National Center for Scientific Research (CNRS), University of Franche-Comté, CNRS, National Engineering Institute of Mechanics and Microtechnology, University of Technology Belfort-Montbéliard, the three latter being now gathered under the common banner of a unique federal regional university, University Bourgogne Franche-Comté (UBFC).

Our activities cover obviously many different themes within the broad discipline of engineering sciences, from fundamentals to applications. Each scientific department dedicates intense efforts to obtain world class level scientific results in its own area. Beyond these internationally recognized focused expertise, we also have a strong dedication to cross-disciplinary interactions whenever it appears both relevant and with high innovative scientific and technological breakthrough potentials.

Biom'@x

SCIENCES ET TECHNOLOGIES:
TOWARDS A TECHNOLOGICAL TRANSLATIONAL MEDICINE

Biom'@x is a pluri-science research axis aiming at developing smart devices able to understand (as fully as possible) a living system under study. This understanding should lead to the determination of behavior laws that, through prognostic approaches, allows anticipating the evolution of these systems with the ulterior motive of personalizing the therapeutic strategies.

This program is fueled by the wide disciplinary spectrum of the FEMTO-ST Institute, in particular in micro and nano-technologies, robotics, informatics, automation, optics, biomechanics, proteomics and e-health. The goal is to solve scientific and technological biomedical obstacles as well as to develop new paradigm in order to tend to a trans-disciplinary vision of research in health domain.

Biom'@x researchers are not only already recognized at the national and international level through their disciplinary work, they also benefit from a strong interaction with Besançon's University Hospital (in particular the Clinical Investigation Center CIC1431), the biology and medicine research local centers, higher education units, especially in the biomedical and micro techniques fields, and the industry, in a privileged "Research-Translation-Transfer" environment in Franche-Comté.

The next pages summarize projects conducted in the frame of Biom'@x.

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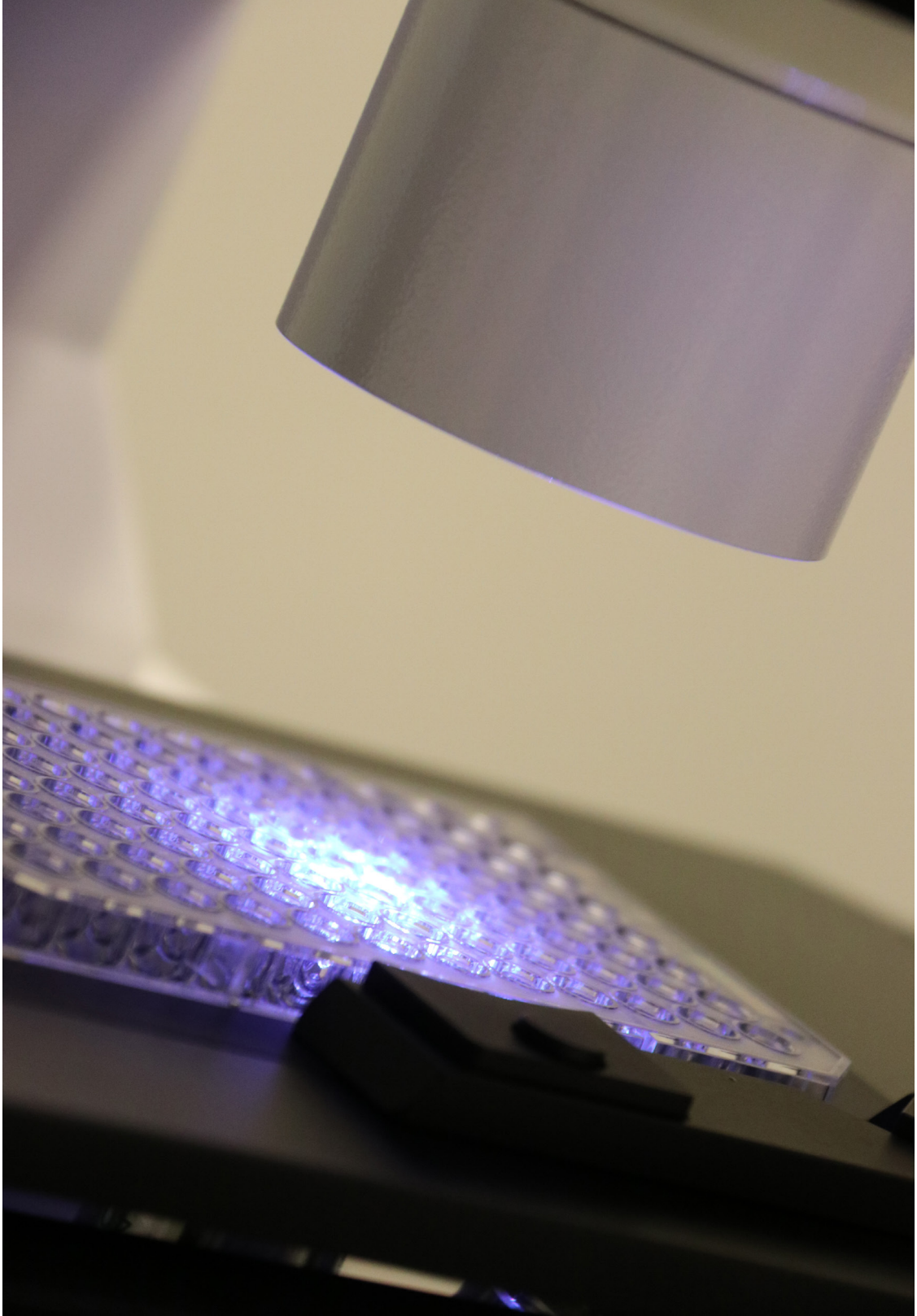
WATCH THE VIDEO
http://bit.ly/2ExpLjM

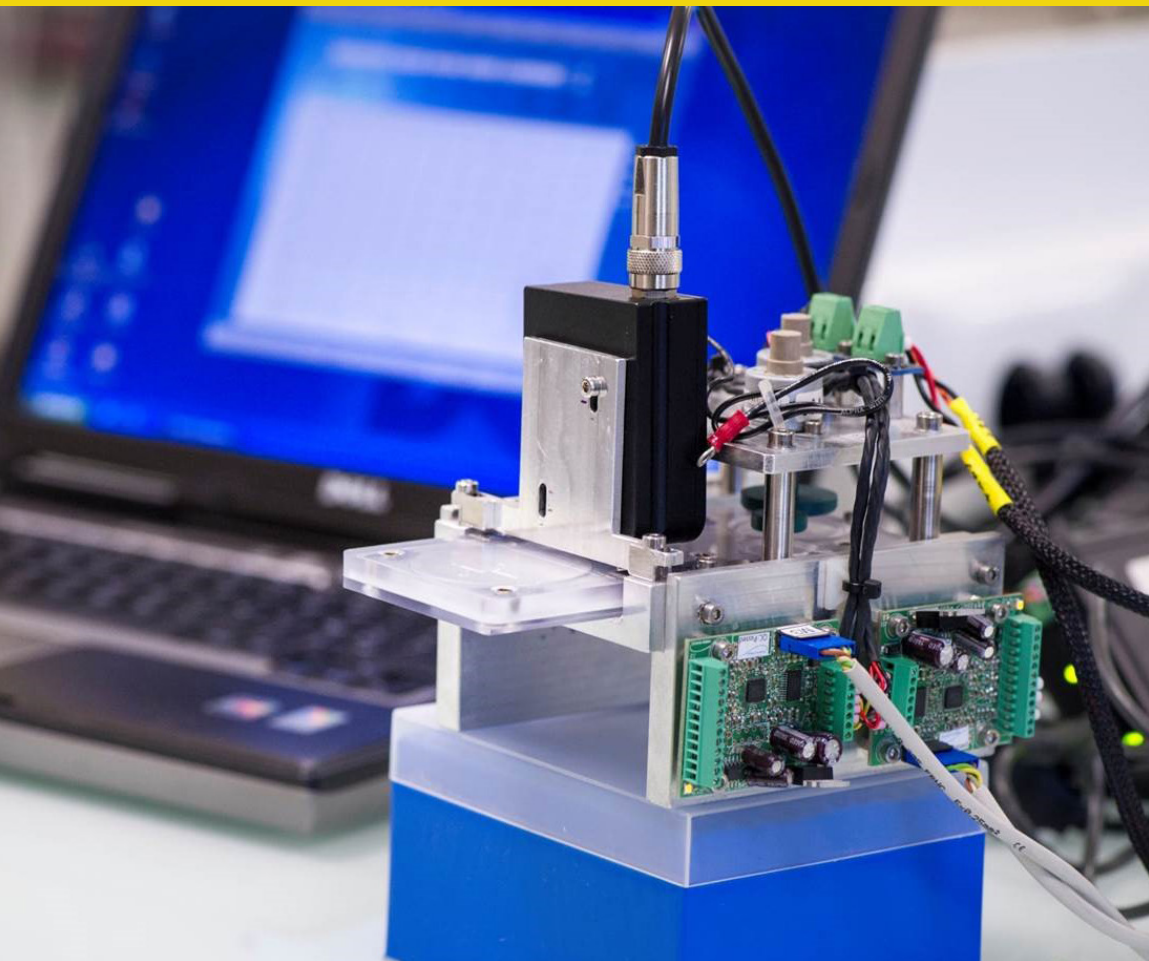
janvier 2022



femto-st SCIENCES & TECHNOLOGIES

Biom'@x

CURRENT PROJECTS

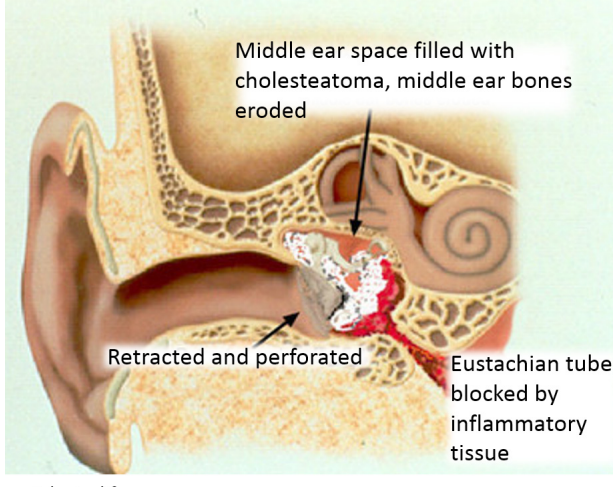


µRoCS

MICROROBOT-ASSISTED CHOLESTEATOMA SURGERY

Cholesteatoma is a skin growth that occurs in an abnormal location in the middle ear. It is usually due to repeated infections. It was estimated that one new case per 10,000 citizens occurs each year. Over time, cholesteatoma expands in the middle ear, filling in the empty cavity around the ossicles and then eroding the bones themselves (ossicles, mastoid). Cholesteatoma is often infected and results in chronically draining ears. It also results in hearing losses and may even spread through the base of the skull into the brain. Nowadays, the most effective treatment of cholesteatoma is to surgically remove the infected tissues through an invasive procedure. Therefore, there is a real need for a minimally invasive robotic system able to access the epitympanum cavity, with high accuracy and dexterity.

This project is part of the Challenge 4 – Life, Health and Well-being of the ANR call. It will focus in a surgical protocol breakthrough for the middle ear diseases through basic research in robotics, microrobotics, differential diagnosis methods, and image-guided interventions, following a cross-disciplinary approach.



Adapted from: http://drpaulose.com/wp-content/uploads/cholesteatoma.jpg

DURATION

2018 - 2023

FUNDING

687k€ (French National Research Agency)

CONTACT

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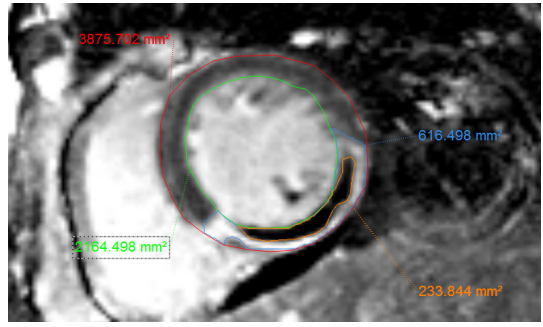
ADVANCES

AUTOMATICAL DETECTION OF DIFFERENT RELEVANT AREAS WITHIN THE MYOCARDIUM

An important parameter for assessing the status of the heart after myocardial infarction (MI) is the viability of the myocardial segment under consideration, i.e. whether the segment will recover its contractile function after revascularization. MRI acquired several minutes after contrast injection is a reference method to assess the extent of a myocardial infarction, and by extension, to estimate the viability of a myocardial segment (in conjunction with the study of muscle contraction from cine-MRI). The main objective of the ADVANCES project is to automatically detect the different relevant areas within the myocardium from a series of small-axis slices covering the left ventricle, and thus to quantify the MI. The segmentation and quantification methods will be based on deep learning approaches.

Many models (based on machine learning and deep learning) have been developed to perform automatic classification of patients with their pathological parameters, automatic segmentation of the MI and estimation of the volume of the infraction.

A challenge with Open data is available on www.emidec.com



DURATION
2018-2021

FUNDING
300K€ (ISITE UBFC)

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BIAcoustic

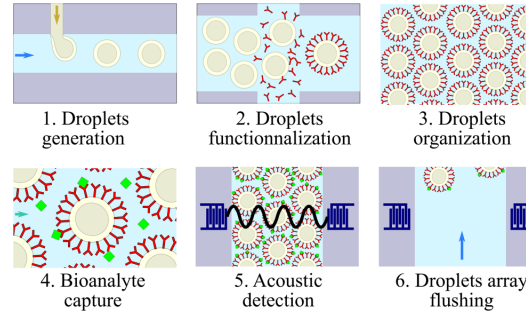
BIO-ANALYTE SENSOR USING ACOUSTO-FLUIDIC IN WATER EMULSION AND FOAM

Since a few years, we are working in the Biomicrodevices team of the FEMTO-ST Institute (www.femto-st.fr) on a new paradigm of bio-analyte sensing.

The principle relies on the capture by ligand of bioanalyte at functionalized surface for estimating the bioanalyte concentration in the liquid. In our case, we propose to capture the bionanalyte on the surface of functionalized droplets/bubbles arranged in dense network followed by acoustic probing for evaluating the quantity of captured bioanalyte. The overall sensor principle of operation is shown in the figure, where we see the main steps of operation: capture, measurement, regeneration.

The sensor has potentially several key advantages over existing techniques used for biomolecular interaction analysis, that are based on flat architecture: increased total capture (increased capture surface for the same sensor surface), increased capture efficiency (strong increase in diffusive transport) and simple regeneration (flushing micro-droplet).

The project aims to make a proof of concept of this new sensor, by first studying the interaction of acoutic waves with droplet, allowing to choose the configuration sensitive.



DURATION

2020-2023

FUNDING

158 k€ (EUR EIPHI/BFC Region)

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BlooDe

CONCEPTION AND VALIDATION OF A MEDICAL COLLAGEN BASED SYSTEM FOR PRIMARY HAEMOSTASIS EVALUATION IN FLOW

Various diseases can cause haemorrhages or thromboses resulting in particular from complications during surgery. This may take the form of a dysfunction of the platelets (haemostasis), the blood cells the role of which is to plug the holes in the damaged blood vessels. Inside an international consortium, involving two companies, two hospitals and FEMTO-ST Instute, a medical device, called Blood Device (BlooDe), has been developped to study the plugging capacity of platelets. BlooDe can detect deficient platelet-related haemostasis of a subject effectively and in advance of an invasive procedure. It artificially reproduces blood circulation and injuries in the vessel walls, and can test patient's platelets with sufficient accuracy in few minutes using only a few millilitres of blood. This device delivered in 2019 is currently being tested in a clinical trial (name: INDONESIA, ref. NCT03773159).

Since 2020 several testing campaigns with an integrative assay of primary haemostasis in flowing anticoagulated whole blood from patients are currently underway. Based on the feedback from this initial study, additional functional specifications have been identified to lead to a second prototype with increasing performances and functions. The current researches and developments are undertaken with a short-term objective of disseminating this technology in an international clinical network and surveying the market.

DURATION

2016-2023

AMOUNT FUNDED:

185 k€ (INTERREG V, 2016)

105k€ (Franche-Comté Burgundy Area, 2020)

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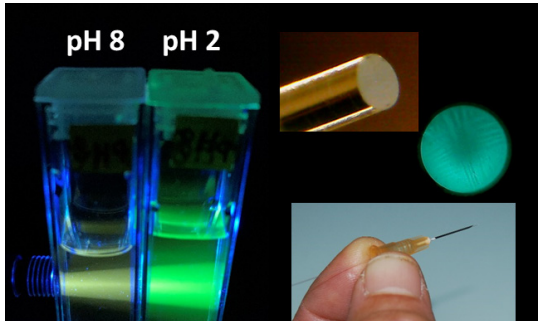
CFpH

CALIBRATION FREE OPTICAL PH SENSOR USING FLUORESCENCE OF FLUORESCEIN MOLECULES GRAFTED AT THE END OF AN OPTICAL FIBER

This project is the continuation of the MELpH project, which following the results obtained and the filing of a patent, entered the maturation phase. Unlike existing optical techniques, we do not work on the measurement of the fluorescence intensity at one or two wavelengths, but on the whole form of the fluorescence spectrum of the molecules of fluorescein chemically grafted at the end of an optical fiber. This allows to calculate both the pH seen by the probe and the pKa of the fluorescein protonation equilibrium between its two fluorescent species. The size of the probe (200 µm diameter) allows the measurement in liquid volumes of a few microliter and the speed of the measurement (100 ms) allows to consider the follow-up of kinetics. With this way of proceeding, one becomes independent of the variations of the fluorescence intensity due to the phenomena of bleaching, quenching and possible variations of the pKa caused by the ionic strength of the sample. This leads to measurements without calibration of pH between 5 and 8 with a precision of 0.01 pH unit.



DURATION
2020-2022

FUNDING
260 k€ (SATT Sayens)

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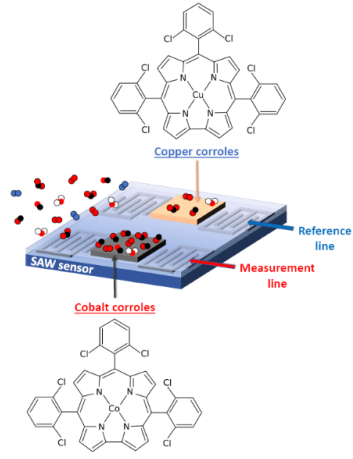
CO2DECIN

CARBON MONOXIDE (CO) AND CARBON DIOXIDE (CO_2) DETECTION IN CAR INTERIORS

On a daily basis, we are exposed to atmospheric pollutants emitted in particular by car traffic. CO is responsible for>350 deaths per year in France (5000 hospitalizations). The aim of CO2DECIN is to design mixed carbon monoxide (CO) and carbon dioxide (CO_2) sensors based on the selective adsorption properties of these gases by active and porous molecular materials in view to develop new marketable sensors. CO detection is a crucial point for industry and domestic purposes but the current CO sensors are limited either by a low selectivity towards other gases or by a low sensibility.

This consortium, with 3 industrials (PSA, ETHERA and frec|n|sys) and 2 laboratories, proposes to elaborate a new family of dual CO/CO_2 sensors based on the surface acoustic wave (SAW) technology, associated with a specific molecular material functionalization (COF based on cobalt corroles or MOF based on triazacyclononanes synthetized by ICMUB). The mass detection system developed by FEMTO-ST is based on the principle of quartz microbalance. Quantification is based on the slowing down of the propagation speed of the waves due to the mass deposited on the device's surface. The use of Love waves can gain a factor of 10 in sensitivity compared to a conventional quartz microbalance. A reference element is subjected to the same conditions as the test body in order to subtract the background noise. This technology has already achieved a detection limit for CO below 80 ppb.



DURATION

2019-2023

FUNDING

340 k€ (ISITE UBFC – Industrie)

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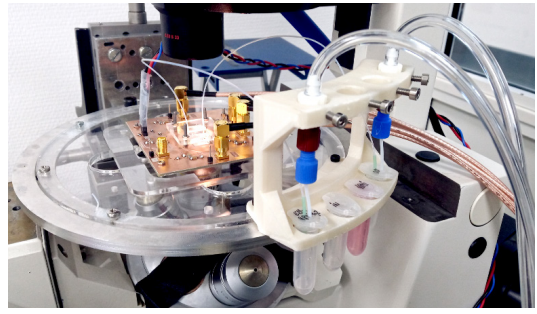
CoDiCell

CODICELL DEVELOPS TRAJECTORY CONTROL OF LARGE POPULATIONS OF BIOLOGICAL CELLS INSIDE FLUIDIC CHIPS FOR THE DEVELOPMENT OF ADOPTIVE CELL THERAPY.

This project paves the way to adoptive cell therapy for anticancer treatments. This highly personalized technique is based on the cloning of naturally occurring tumor-reactive lymphocytes. However, in most cases, this treatment must face a major challenge: the identification of these rare natural lymphocytes having a concentration lower than 0.1%, which is beyond the detection level of current techniques. CoDiCell proposes a sorting device which consists in placing the lymphocytes one by one in front of tumor cells by means of dielectrophoretic actuation and in identifying the lymphocytes which bind to the tumor cells. The targeted lymphocytes are then collected in a dedicated microchannel.

To reach this goal, the project develops methodologies for the trajectory control of large populations of cells inside fluidic chips at high speed. It combines approaches coming from the microfluidics and the microrobotics communities. Microfluidic chips ensure fast and long range displacements of large population of cells while microrobotics develops precise control of the trajectory of individual cells.

This multidisciplinary project, funded jointly by the French agency ANR and the Swiss agency FNS, is based on the complementary competences of three institutions: CNRS (FEMTO-ST and ISIR institutes), EPFL in Switzerland and EFS (Etablissement Français du Sang).



DURATION
2018-2022

FUNDING
637 k€ (ANR/FNS)

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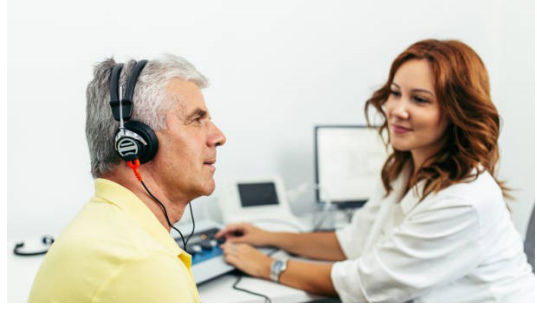
DASHES

NEW DATA-DRIVEN TECHNIQUES FOR THE DIAGNOSIS, PROGNOSIS AND REHABILITATION OF IMPAIRMENTS OF SPEECH PROSODY PERCEPTION IN BRAIN-STROKE SURVIVORS.

Hearing impairments concern up to 86% of brain-stroke survivors, a 38% excess compared to controls of the same age, yet stroke-related hearing is not as well studied as the more obvious symptoms of aphasia or motor loss. The objectives of project DASHES is to improve the diagnosis, prognosis and rehabilitation of hearing disorders in stroke survivors. Specifically, we aim to study impairments of speech prosodic perception using a novel data-driven system identification technique, reverse correlation.

The project will, first, conduct a prospective diagnostic study on N=60 stroke patients and controls, in order to evaluate the relevance of reverse-correlation data as a marker of prosodic impairments. Second, the project will use this novel patient data for theoretical investigations such as lesion-symptom mapping, in order to better understand how prosodic processing differ between patients and controls. Finally, the project will develop a novel mobile audio-health platform to facilitate the adoption of the reverse- correlation procedure in clinical practice and to collect remote patient data to assist medical decision- making.

Collaboration with Dr Marie Villain and Prof. Lionel Naccache, APHP Pitié-Salpêtrière (Paris).



DURATION

2018-2023

FUNDING

40k€ (Fondation pour l'Audition, 2018); 200k€ PHRIP ProsAVC (2019); 300k€ (submitted, Fondation pour l'Audition, 2021)

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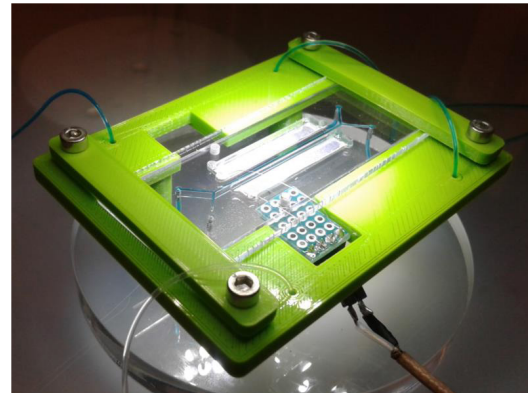
DIMESUR

SEPARATION AND QUANTIFICATION OF BIOLOGICAL ELEMENTS PRESENT IN A COMPLEX BIOFLUID.

The project is divided into three parts, all of which concern the design and fabrication of innovative microsystems and use piezoelectric materials: an acouto-optical modulator for telecommunication applications, a non-contact sorting system for biological material and a device for the detection/quantification of biological elements in complex fluids. Manipulating micro and nano-biological particles like extracellular vehicles (EVs), without extracting them from their biological media, presents a big challenge for diagnosis purposes in a wide set of pathologies. We propose a combination of technologies that can provide the required set of information needed for assessing EVs. The sorting device is based on the combination of microfluidic and electroacoustic modules that is capable of aligning and sorting submicron biological particles according to their size, compressibility or mass density, all in a tunable way. The detection/quantification device is a fully tunable system able to generate mode localization between a high Q-quartz crystal microbalance at 1MHz and a digital device. This label-free device is promising to reach sensitivity at least two orders of magnitude higher than the ones found in the literature and a very low limit of detection.



DURATION
36 months

FUNDING
296 k€

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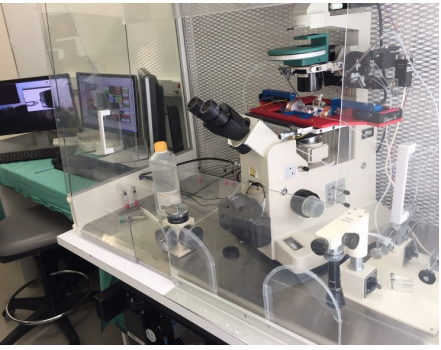
EGG



MECHANICAL CHARACTERIZATION OF HUMAN OOCYTES

This project is focused on the validation in a Medically Assisted Reproduction laboratory of an experimental platform developed at FEMTO-ST that is dedicated to the mechanical characterization of human oocytes.

This maturation project is focused on the development of an intelligent medical device that will help physicists to qualify human oocytes before IVF by using a mechanical characterization based on indentation. The goal of this project is to validate in a real Medically Assisted Reproduction environment a patented prototype that was previously developed at FEMTO-ST (CARMEO project). The new plaform developed at the Besançon University Hospital has to comply with all the constraints imposed by the hospital environment and also by the Biomedicine Agency concerning medically assisted procreation. Four development axes are included in the project in order to reach TRL 5-6:

- The extention of the existing patent to international and the reseach of industrial partners.

- The duplication and redesign of the current FEMTO-ST platform at Besançon University Hospital by adapting it to a Medically Assisted Reproduction environment.

- The calibration of the measurement process and the fiabilization of the nanoforce measurement (with its control algorithm) that are performed during oocyte indentations.

- The complete testing of the new platform on oocytes that have been excluded from an IVF program and that are at different stages of maturation.

The new platform will be based on an active magnetic force sensor that uses an autostabilized magnetic spring (AMS) and an innovative control algorithm for the indentation that is called VIRCO. The resulting control of the indentor displacement will be extremely robust despite the fact that human oocytes have very diversified and evolutive mechanical responses. The development of this new platform is fully supported by the SATT Grand Est.

DURATION

2018 - 2020

FUNDING

107 k€ (SATT Grand Est)

CONTACT

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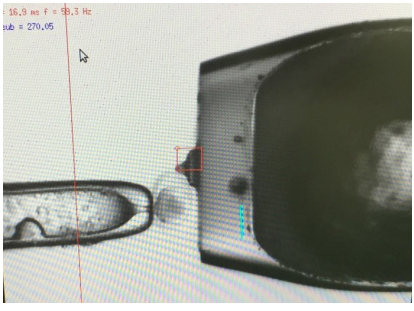
EGG next



MECHANICAL CHARACTERIZATION OF HUMAN OOCYTES

This project aim to consolidate the results previously obtained in a Medically Assisted Reproduction laboratory with the EGG platform for the sorting of human oocytes using mechanical criteria.

This maturation project is an extension of the EGG project. It takes as a starting point the patented plafform developped at Besançon University Hospital by the FEMTO-ST institute for the mechanical characterization of human oocytes. The measurements previously obtained have to be understood and consolidated in order to correctly qualify human oocytes. To reach this goal, several tasks are planned in the project:

- An new improved platform will be developed with top level devices (high resolution manipulators, high quality optical devices for microscopy, high speed camera), top of the art algorithms for observation and control (Higher-Order Extended-State Kalman Filter and VIRCO control) and easy to use interface for physicists in order to have the best possible nanoforce measurements during each controlled mechanical indentation of oocytes.

- The cinetic of the mechanical answer over 3 days of human oocytes that have been excluded from an IVF program will be recorded and modelled thanks to a collaboration with some academic partners in France and USA.

- A small serie of disposable and sterile indentors will be fabricated for a use in a clinical study.

- All the autorizations needed to start a clinical study on human oocytes that are included in an IVF program will be asked.

- A first clinical study on 20 volontary patients will be done with the new platform in order to obtain mechanical characterizations of oocytes before their fecondation and embryo implantation in the uterus. The objective is to obtain some first correlations between the oocytes mechanical data and the chance of pregancy after implantation.

All these tasks are fully supported by Sayens.

DURATION

2021 - 2023

FUNDING

362 k€ (SAYENS)

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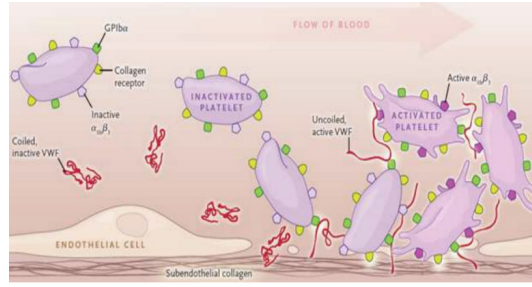
GHOST

STUDY OF THE PRIMARY HEMOSTASIS

Primary hemostasis is the initial step, which culminates in a platelets plug and precedes the formation of the blood clot. Defects may predispose to hemorrhage whereas platelets deposits within the lumen may culminate in thrombosis. The key factors are, in addition to circulating platelets, plasma, von Willebrand factor and the vessel wall and more specifically collagen of the matrix exposed in cases of vascular damage or of rupture of an atherosclerotic plaque.

Most of the currently available devices are for research use only and those for clinical use have serious limitations. The objective of this project is to develop a totally innovative microfluidic device system to explore, in clinical practice primary haemostasis as a whole with smallest blood volumes and immobilized recombinant collagenlike proteins, in flowing whole blood under the appropriate rheological conditions. A multiparameter acoustic biosensor will be integrated to perform real time measurements.



DURATION

2017 - 2021

FUNDING

450k€ (French National Research Agency)

CONTACT

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GRAND PRIX SCIENTIFIQUE 2018

FONDATION
CHARLES DEFFOREY
INSTITUT DE FRANCE

MINAROB : MICRO/NANOROBOTICS FOR BIOMEDICAL APPLICATIONS

The 2018 edition of the Scientific Grand Prize of Fondation Charles Defforey was dedicated to «Mechanics, Robotics and Artificial Intelligence» and came to support the work of the Biomedical Micro / Nano-Robotic team (MiNaRoB: N. Andreff, M. Gauthier, A. Bolopion, B. Tamadazte, R. Dahmouche, K. Rabenorosoa, P. Rougeot, M. Dulmet, C. Perrard and many post-doctoral fellows, doctoral students and interns) created in 2012 at the AS2M department.

This work splits into 4 scientific areas: contactless manipulation, medical micromechatronic design, image-guided surgery, and intracorporeal dexterity. The approach is always the same, starting from understanding unmet clinical needs and aiming at the realisation of novel clinically realistic proofs of concept, through methodological investigation and technical development, It is followed in tight cooperation with medical doctors (mainly from CHRU Besançon) and other research institutes (namely, a strong connection with iCube Strasbourg and ISIR Paris).

The current work focuses on optimal and adaptive scanning strategies for fast and accurate optical coherence tomography (OCT) and OCT-based robot control; multiview geometry for small bowel inspection with miniaturised videocapsules; design of soft atraumatic robot-assisted medical devices in the digestive tract; wireless dexterous magnetic manipulation with mobile electromagnets; and various exploratory topics.

DURATION
2018-2023

FUNDING
450k€ (Fondation Charles Defforey et Institut de France)

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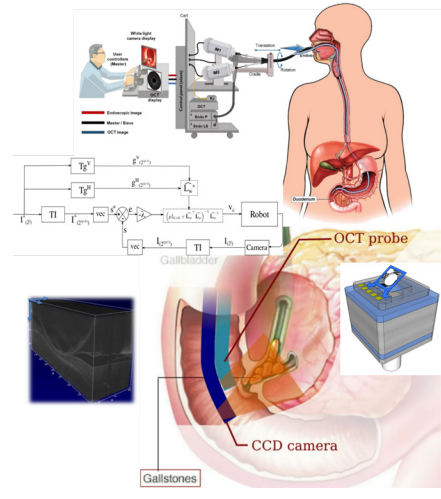
Inserm ROBOT

ROBOTICS AND OPTICAL COHERENCE TOMOGRAPHY (OCT) FOR OPTICAL BIOPSY IN THE DIGESTIVE TRACT

This project, involving the AS2M (N. Andreff, B. Tamadazte) and the MN2S (C. Gorecki, S. Bargiel, O. Gaiffe) departments at the femto-st institute and the EAVR team (F. Nageotte, M. Gora) at the iCube laboratory in Strasbourg, proposes a disruptive approach to cancer diagnosis in the digestive tract. It deals with fundamental research, yet it is deeply inspired by the clinical needs and it mixes mathematics (compressed sensing, robot control), physics (optics) and engineering (optical MEMS, robotic endoscope, flexible continuous robot). The purpose of this project was to develop an optically coherent tomography (OCT) microscanner, held stable and accurately driven by a two-stage robotic system, made of a robotized endoscope equipped with a dexterous flexible micromanipulator.

Thereby, the following results were achieved: 1) a miniature in-silico OCT scanner based on swept-source Mirau interferometry, 2) assessement of compressed sensing algorithms in view of sparse OCT volume acquisition, 3) development of novel scanning strategies, 4) novel algorithms for robot control based on OCT feedback and their parallel implementation (GPU), 5) use of both white-light images and OCT signal in the control of the endoscope holding the scanner, especially in view of motion compensation.



DURATION
2017-2021

FUNDING
450k€ (INSERM)

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MASSAI

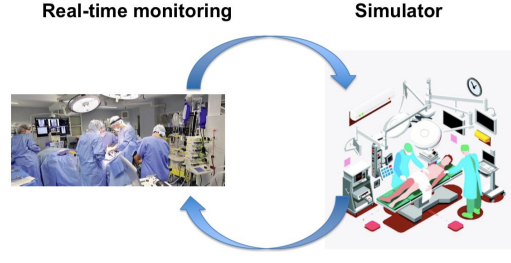
MODELLING AIDS FOR SAFE SURGERY USING ARTIFICIAL INTELLIGENCE

In surgery rooms, organizations and technologies are more and more sophisticated. Medical staffs and teams are confronted to more and more complex situations. Even if the «zero risk» can not be reached, our institutions must go further on the improvement of healthcare security for their patients. Being able to anticipate and alert at any possible incident for the patients is of the utmost importance.

The MASSAI project aims at reducing the risks during surgery, detecting and anticipating the potential incidents and proposing corrective actions in real-time. This informatic tool will be based on concepts taken from Artificial Intelligence and will modelize encountered actors and situations. It will be connected to different sensors placed in the surgery room. The part of the system responsible for the risk detection will previously be trained on the recognition of risky situations and incidents met in the past.

In addition to the advantages expected for the patient security, this project will help surgical departments to optimize their resource management. It will also help to train surgical staff and analyze the actual corrective actions. This tool must also respect the rules linked to ethic and privacy.

This european project is led by FEMTO-ST with different partners: CHRU of Besançon and Aprogsys.



DURATION

2019-2022

FUNDING

637 k€ (FEDER and BFC region)

CONTACT

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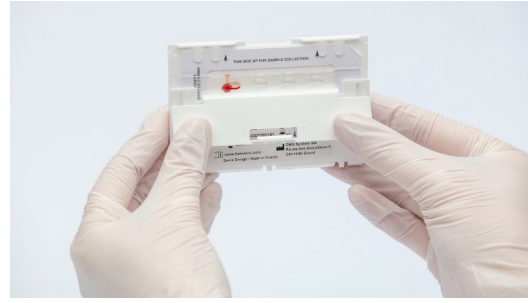
METEOR

HIGH PERFORMANCE FUNCTIONAL COATINGS FOR WATCH COMPONENTS, DIAGNOSTICS AND ANTIMICROBIAL MEDICAL INSTRUMENTATION

The METEOR project (interreg 2020-22, partner FEMTO-ST, CSEM, DBS, PureLabPlastics, Coloral) is divided into two distinct parts:

1) Devices for individualized and externalized blood sampling. As part of the project, we are developing purification processes to remove metal cations presented in cellulose matrices. These matrices are used to store blood after collection before analysis. The results are very promising. We have demonstrated a complete and industrializable process.

2) Developments of antimicrobial surfaces. As part of the project, we are interested in the development of antimicrobial aluminum surfaces for biomedical purposes. The idea here is on the one hand to find an alternative to tools usually made of stainless steel; on the other hand, these surfaces, in addition to their mechanical and temporal resistance, must have antimicrobial properties thanks to the adsorption of bioactive molecules in the aluminum coating process. The promising results at the laboratory scale allow us to consider a study towards industrialization.



@DBS

DURATION
2020-2022

FUNDING
525 k€ (INTERREG FEDER)

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MIMÉDI

GIVING MORE PEOPLE A CHANCE TO ACCESS ADVANCED THERAPY MEDICINAL PRODUCTS

Innovative medicines have recently emerged to offer new treatment solutions for patients in therapeutic deadlocks. ATMPs are medicines based on genes, tissues or cells. Their current manufacture requires use of complex and costly technologies. Ten industrial and academic partners from engineering sciences and cellular engineering are currently working to reduce fabrication costs by optimizing production process, improving control process and speeding up the development time of new medicines.

The FEMTO-ST Institute contributes to this project by i) providing solutions based on microfluidics and microrobotics to select rare cells and ii) qualifying and controlling cells and contaminations which could occur during production by combining its known-how on micro-nano systems, microfabrication, micro and nano-bio technologies, cell biology and optical spectroscopy.

Developments include microfluidic devices based either on dielectrophoresis to select cells based on the use of variable electric fields, on acoustophoresis to sort, wash, concentrate cells and separate cell from bacteria with the help of a specific microfluidic bench for automated processes and/or on tangential filtration to separate lymphocytes from RBCs. Other developments enable to monitor cell growth and detect contaminations based on different absorption (optical) spectra from cell and bacteria and to qualify cells and control for eventual contaminations by nanobiotechnologies.

DURATION:
2017-2022

FUNDING:
15M€ (FEDER RIS3 / BPI)

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MISTRAL

DEVELOPMENT OF A MICRO ANALYTICAL PROTOTYPE FOR SCREENING LUNG CANCER VIA DETECTION OF VOLATILE BIOMARKERS IN HUMAN BREATH

An innovative way for the early diagnosis of lung cancer is to analyze the chemical composition of human breath. Breath analysis provides a simple and convenient alternative to traditional medical screening in clinical laboratory, because it is non-invasive, pain-less, cost-effective and it can be easily repeated. In this project a prototype system was developed for monitoring a set of potential lung cancer biomarkers (toluene and propanol as example).

This micro-analytical system has a miniaturized single SnO_2-based gas sensor as detector, and is equipped with a silicon gas chromatographic (GC) micro-column and a silicon gas micro-preconcentrator.

The objectives of this project are: (a) to develop an efficient and reproducible sampling procedure for the human breath collection, (b) to study the response of the prototype under various human breaths (healthy or artificially polluted breaths) and (c) to prepare the regulatory files necessary for a futur clinical investigation.

This project is based on the close collaboration of 4 laboratories (FEMTO-ST/MINAMAS (Besançon), CHRU (Besançon), ICB/ASP (Dijon) and IJL/ N2EV (Epinal)) with complementary knowledge and was recently supported by the Bourgogne Franche-Comté regional council (MISAVOC APIRBFC).

DURATION
2020-2022

FUNDING
15 k€ (APIRBFC)

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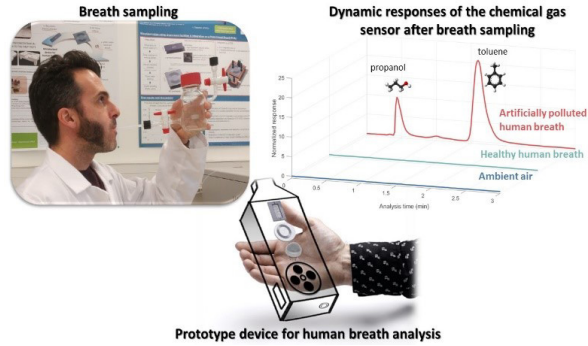

MMVIIH

MULTISCALE MODELLING OF THE VIBRATION-INDUCED INTIMAL HYPERPLASIA.

Workers regularly exposed to Hand Arm transmitted Vibration (HAV) are likely to develop the vibration-induced Raynaud's syndrome. This vascular disorder may be characterized in part by an arterial growth and remodelling potentially induced by an Intimal Hyperplasia (IH) phenomenon. We suppose that the Low Shear Stress (LSS) produced inside digital arteries after HAV exposure leads to the IH formation. Therefore, our aim consists in building a multiscale mechanobiological framework of the LSS-induced intimal hyperplasia. This framework is based on an Agent-Based Model (ABM) that describes the dynamics of arterial cells, coupled with a Finite Element Model (FEM) characterizing the hyperelastic behaviour of the artery. The input data are the LSS values calculated inside the digital artery after exposure to HAV. The cells dynamics modelled inside the ABM are modulated by the LSS as well as the stress field yielded by the coupled mechanical model. Moreover, the initial goemetry of the FEM is created at each coupling step in order to consider the arterial growth modelled by the ABM. This framework will help at predicting the arterial growth induced by different HAV exposureconditions. Eventually, this will lead to the implementation of more adapted prevention strategies for reducing vibration exposure.

DURATION
2018-2024

FUNDING
INRS 2 Ph.D. grants

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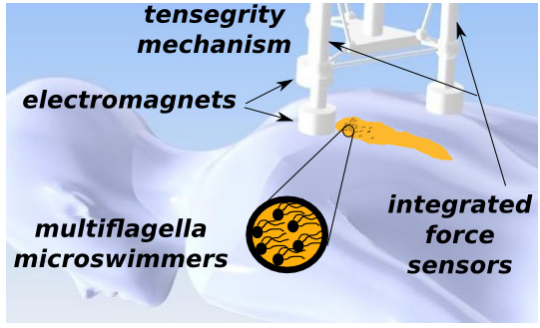
MULTIFLAG

DESIGN AND CONTROL OF MULTI FLAGELLA MICROSWIMMERS DRIVEN BY MOBILE MAGNETS

MultiFlag is a joint project between ISIR laboratory at Sorbonne Université (S. Régnier, project leader), iCube laboratory at University of Strasbourg (P. Renaud, M. Vedrines) and FEMTO-ST institute at University Bourgogne-Franche-Comté (N. Andreff, A. Bolopion). It deals with three main scientific issues related to the long term goal of wireless manipulation of therapeutic agents, swimming in the spine, through the use of a variable magnetic field. First and main task at ISIR, magnetic microswimmers are designed with several flagella to optimise their swimming speed and intrinsic manoeuvrability. Second and main task at femto-st, control of the magnetic field is addressed to maximise the extrinsic manipulability of the microswimmers under the constraints of reduced footprint and heating of the magnetic field generator, which implies to use a reconfigurable system made of several mobile electromagnets of a reasonable size. Third and main task at iCube, a lightweight mechanism is designed, built and controlled, under the tensegrity paradigm which consists of balancing a structure made of struts in compression and cables in traction, in order to minimize the dimensions of the electromagnet manipulator while maximizing safety for the patient and the clinical staff.



DURATION
2016-2021

FUNDING
400k€ (ANR), 138k€ (FEMTO-ST)

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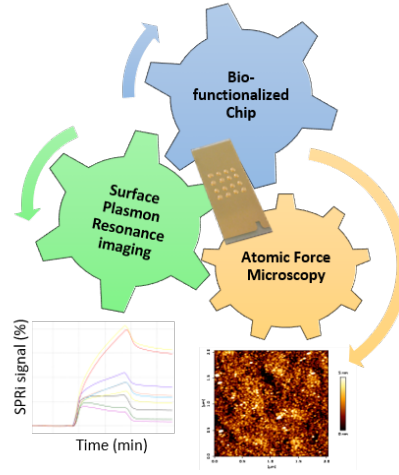
MYELOMA

A NANOBIOANALYTICAL PLATFORM TO HELP FOR DIAGNOSIS OF MYELOMA

There is clearly a link between myeloma, blood cancer, and hemostasis problems. The objective of the project is to identify this link: what element released by the myeloma causes the thrombosis - the appearance of clots - to be more important and create an imbalance in hemostasis? There is a good chance that it comes from the extracellular vesicles (EVs) derived from myeloma cells.

Anticipating myeloma development could be considered through a specific reading of the blood components that unbalance hemostasis : by very finely analyzing the plasma of patients and qualifying the EVs.

The project consists in designing a multiplexed biochip which will selectively trap vesicles derived from myeloma cells. The complexity of the project will be especially to highlight a differential expression of membrane proteins in EVs according to the cases of myeloma analyzed.



DURATION

2020-2021

FUNDING

62 k€ (FFRMG)

CONTACT

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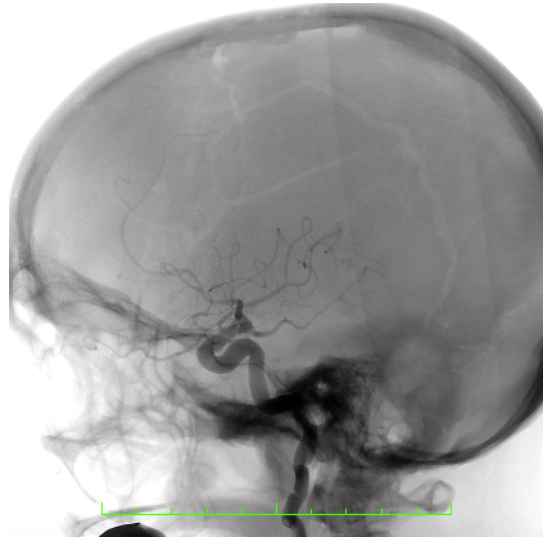
NRI-ROBOT

ROBOTIC-ASSISTED NEURO-ENDOVASCULAR INTERVENTIONS

In this project, FEMTO-ST and CHRU Besançon aim to develop robotic technologies aided neuro-endovascular interventions by using biplane interventional imaging. Three main issues will be addressed: reduce the learning period in order to increase the number of surgeons, investigate the remote control of the neuro-interventions, and develop mechatronics technologies to improve safety and intervention successes.



DURATION

2021-2025

FUNDING

25 k€ (PIREG CODA)

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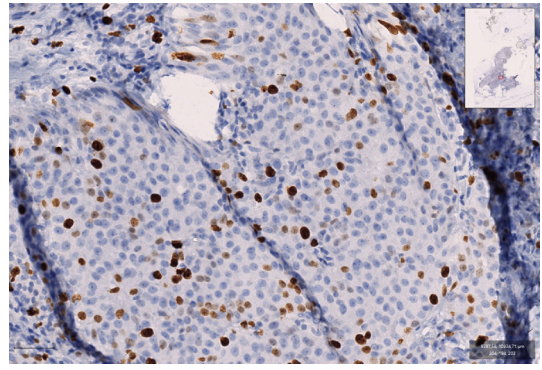
PADICS

PADICS PROJECT AIMS TO PROVIDE A DECISION-MAKING SUPPORT TOOL TO HELP PATHOLOGISTS IN THEIR DIAGNOSIS FOR BREAST CANCER

Digital pathology for breast cancer (PADICS) project is a research project that aims to improve the workflow of digital pathology and the accuracy of breast cancer diagnosis. The Oncotype DX (ODX) is the most widely used test to determine a recurrence score and chemotherapy benefit. A less expensive alternative solution to ODX testing is needed. The Ki-67 proliferation biomarker proves to be a good prognostic factor. However, the assessement of this latter remains uncertain. The aim of PADICS is hence to propose a digital pathology workflow and a new methodology focused on the improvement of the Ki-67 computation score in order to propose an efficient alternative prediction approach of ODX.

The purposes of this project are to:

- digitize the whole-slide images and to structure the database;
- develop a tool based on deep neural networks and machine learning algorithms in order to make the measurement more precise;
- include expertise in the development process;
- deal with the problem of data quality;
- automate the counting process to help pathologists at North Franche-Comté Hospital in the diagnosis process.



DURATION
2020-2022

FUNDING
62k€ (EIPHI Graduate school)

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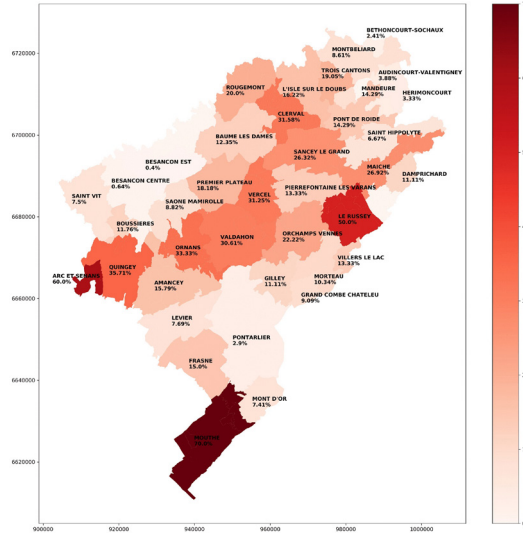
PREDICTOPS

EVALUATION OF BREAKDOWN SITUATIONS IN THE FIRE SERVICE AND OPTIMISATION

Over the years, fire departments have been searching for methods to identify their operational disruptions and establish strategies that allow them to efficiently organize their resources. The present project develops a methodology for breakage calculation and another for predicting disruptions based on machine learning techniques.

The main objective is to establish indicators to identify the failures due to the temporal state of the organization in the human and vehicular material. Likewise, by forecasting disruptions, to determine strategies for the deployment or acquisition of the necessary armament. This would allow improving operational resilience and increasing the efficiency of the firemen over time.

The methodology was applied to the Departmental Fire and Rescue Doubs (SDIS25) in France. However, it is generic enough to be extended and adapted to other fire departments. Considering a historic of breakdowns of 2017 and 2018, the best predictions of public service breakdowns for the year 2019, presented a root mean squared error of 2.5602 and a mean absolute error of 2.0240 on average with the XGBoost technique.



DURATION

2019-2022

FUNDING

110 k€ (CIFRE funding)

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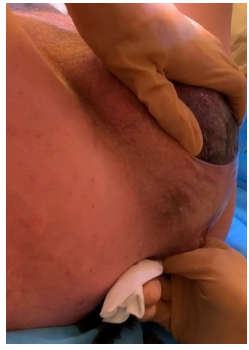
RIPTEAR

ANALYZING AND UNDERSTANDING THE MECHANISMS BEHIND PERINEAL TEARS DURING DELIVERY

Mechanical properties ensure safe perineal behavior in standard conditions. During delivery, the perineum undergoes large deformations leading to perineal tears and their consequences. Severe perineal tear with obstetrical anal sphincter injury named OASI occurs after up to 6% deliveries.

The project consists in analyzing and classifying perineal tears in a patient specific approach in order to better understand their mecanisms, to prove that episiotomy does not prevent from OASIs, to help their diagnosis, and to predict them using objective data. *Ex vivo* mechanical tests are conducted to provide realistic parameters. They will be introduced in a structural model of pelvic floor submitted to stress fields during delivery. Fracture properties of soft tissues are investigated to determine an extensibility threshold that can be linked to non linear behaviour of soft tissues exposed to large deformations. Patient specific perineal tears will be correlated to mechanical parameters of tissues or mechanical sollicitations associated to the posision of fetus during delivery. Thank to objective data obtained during this project, a mathematical algorithm predicting the risks correlated to OASIs will be created. This tool will be used by practitioners in order to prevent OASIs during deliveries.



DURATION

2021-2021

FUNDING

7.2 k€ (Chrysalyde UFC)

CONTACT

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R-LiNK

IMPROVING THE ADHERENCE TO LITHIUM TREATMENT FOR BIPOLAR PATIENTS BY MEANS OF A SELF-MONITORING DEVICE

The research developed in this project is part of the H2020 European Project R-LiNK. The consortium consists of 22 European partners including research institutes, hospitals, Clinical Investigation Centers and SMEs.

Bipolar disorder (BD) is a prevalent mental disorder and a leading cause of suicide. Lithium is the key mood stabilizer for prevention of BD relapse and suicide. Whilst many cases become asymptomatic with lithium treatment, the majority show sub-optimal response. Identifying biomarkers for predicting lithium response would enable personalization of treatment define criteria for stratification of BD cases and further refine the clinical response phenotype. In fact, 1/3 of patients under lithium treatment show impressive improvements of the mental health. 1/3 show no response to the treatment. For others the poor adherence to treatment may be the cause of an apparent non-response to lithium therapy.

One of the objectives of the R-LiNK project is to develop a self-monitoring medical device used to enhance adherence to treatment and monitor the Li level in saliva. The idea is that, becoming actors of their treatment, patients will increase their adherence to lithium therapy.

Source: http://www.onhealth.com/content/1/bipolar_disorder

DURATION
2018 - 2023

FUNDING
7,7M€ (H2020 European Project)

CONTACT
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SAIAD

AUTOMATIC SEGMENTATION OF NEPHROBLASTOMA OF KIDS USING DISTRIBUTED ARTIFICIAL INTELLIGENCE

Nephroblastoma is the abdominal cancer tumour the most frequently observed in children's kidneys. Its diagnosis and the planification of the surgery are exclusively based on imagery. The segmentation is a key-step of the construction of 3D representations of kidneys, tumours and all the structures around. Such representations would give precious information to surgeons about the tumour itself, as well as the structures infected and the material required for the surgery (quantity of blood, etc.). Nevertheless, nowadays, this segmentation step cannot be performed without any surgeon help since segmentation methods are not capable of accurately separate tumour from other structures like muscles for example.

The main objective of this project is to create a distributed platform which will be able to take in charge the entire process of creating of 3D representation of children's nephroblastoma. At the end of this segmentation process performed on the distributed and secured platform by tools of artificial intelligence (deep learning, case-based reasoning), experts will be able to manipulate 3D holograms and printings of all the structures.

This european project is led by FEMTO-ST with different partners of Switzerland and France: CHRU of Besançon, IDO-In, EPFL, CFI, Mirrakoï and Ennoïa.

DURATION
2016-2022

FUNDING:
1M€ (FEDER / INTERREG)

CONTACT
julien.henriet@univ-fcomte.fr

SEPIA

SENSORY AND EMOTIONAL PROCESSING IN AUTISM SPECTRUM DISORDERS

With approximately 67 million individuals affected worldwide and a prevalence of 1/150, Autism Spectrum Disorder (ASD) is the fastest growing neurodevelopmental disorder (Lyall et al., 2017). In France, this condition affects approximately 600,000 individuals, who have a major handicap in daily life adaptation. Yet so far, no biological or biochemical markers exist to improve diagnosis or therapy for ASD. Identifying the core socio-emotional and/or cognitive deficits operating in ASD, thereby better understanding the physiopathology of the disorder, is key to improve this situation. The co-occurrence of atypical sensory processing and unusual/absent emotional reactions in ASD is notably well documented in the context of vocal emotional prosody: atypical prosodic production is a hallmark of ASD and has been linked to poor children socialization skills. In parallel, adults and children with ASD also have lower performance on emotional prosody perception than controls.

Project SEPIA proposes to use novel data-driven system identification methods (reverse-correlation). to explore how neutral and smiling voices are processed in ASD patients and controls, from stimulus sensory encoding (using electroencephalography - EEG) to auditory-facial mimicry (using facial electromyography EMG). Project SEPIA will allow to disentangle the influence of sensory/perceptive and emotion-related processes and provide novel mechanistic insights into the socio-emotional difficulties of children and adults with ASD.

Collaboration with Dr Marie Gomot (iBrain, University of Tours).

DURATION

2020-2024

FUNDING

500k€ (ANR SEPIA, 2020)

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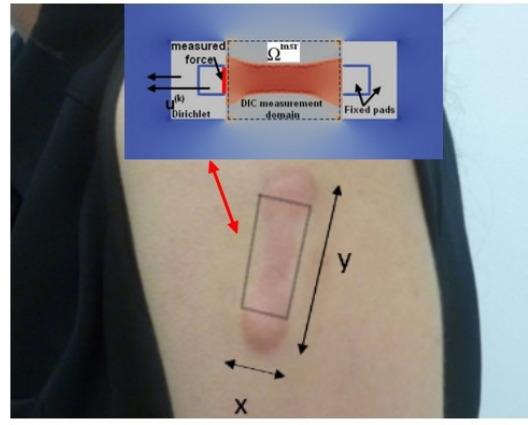
SKUB

SKUB PROJECTS AIMS TO CONCEIVE A CLINICAL SOLUTION TO PREVENT AGAINST KELOID PROPAGATION BY IDENTIFYING ITS PREFERENTIAL DIRECTIONS.

Investigating closely the mechanical behavior of keloids, benign tumors spreading outside the scar margins, is necessary to anticipate their apparition and/or stopping their growth. For that purpose, a patient-specific Finite Element Model Updating framework has been developed to identify the material parameters of the keloid and the surrounding healthy skin from in vivo uniaxial test data [Sutula *et al.* 2019 & Elouneg *et al.* 2019]. By using the identified parameters, the stress fields are computed all over the domain and on the interface keloid/healthy-skin, which will help us to conseive a solution to counter the keloid stretch accoring to its preferential directions. Several parallel projects have been launched with internship students and external teams to improve the accuracy of the methodology as follows. Uncertainties and sensitivity analysis of the inverse method [Elouneg *et al.* 2020]. A multiaxial approach to analyze the anisotropic behavior of the peripheral healthy skin, secured by a commercial device Cutiscan® and readapted to our needs [Elouneg et al. 2020]. Application of the Bayesian inference to estimate the anisotopic model parameters variability inter and intra subjects. An automatic adaptive mesh refinement framework to reduce the computational cost based on Dual Weighted Residual method.



DURATION

2018-2022

FUNDING

Franche-Comté univ. :
1 Ph.D. + equip.
Luxemburg univ. : 1 year Ph.D.

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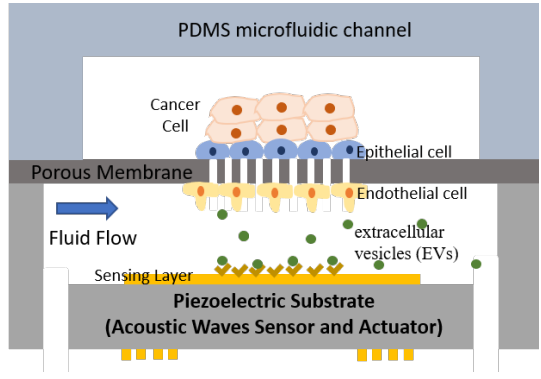
SmOoC

DEVELOPMENT OF SMART ORGAN-ON-CHIP PLATFORM BASED ON HIGHER-ORDER MULTI-MODE ACOUSTIC LAMB WAVES

Organ-on-chip (OoC) is a remarkable example of the convergence of biology and microengineering. OoC has a great potential in revolutionizing the current existing in-vitro approach in drug discovery and development, resulting in a reduction in the needs of animal experiment and accelerate the research and development process for future precision and personalised medicine. However, the complexity of the system is a hurdle in the transfer of OoC system from laboratory to large scale manufacturing and commercial application. The miniaturisation and integration of sensing and actuation components is an important aspect to be addressed to ensure manufacturability of the system. Moreover, a closed loop control system is required to create a smart OoC system that can operate dynamically to process the information and make decisions in a predictive or adaptive manner.

The objective of this proposed research project is to develop a smart OoC system by utilising multimode Lamb waves for sensing, actuation, and control, integrated within a microfluidic system. The successful result of the project will contribute to the development of cost-effective, automated smart OoC system that is suitable for large scale manufacturing to bridge the gap between laboratory and commercial application for drug discovery and future personalised medicine.



DURATION

2020-2022

FUNDING

184 k€ (H2020 Marie Sklodowska-Curie)

CONTACT

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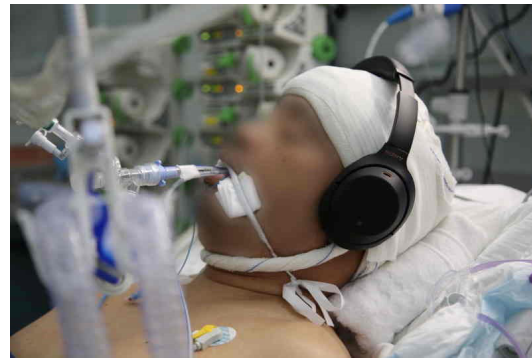
SOUNDS4COMA

TOWARDS A DATA-DRIVEN NEUROPHYSIOLOGY OF AUDITORY CONSCIOUSNESS IN HEALTH AND COMA

The detection of consciousness in non-responsive patients is not only one of the most vexing theoretical questions facing modern science but also a major clinical issue. The possibility that a patient lying down with eyes closed may in fact, through the channel of sound, be covertly comprehending some or all of what is going on around them has far-reaching legal and ethical implications, as evidenced by the recent case of Vincent Lambert in France. The use of sound stimulation in the intensive care unit (ICU) holds tremendous promise to reach to these patients but, despite much research, remains plagued with critical theoretical and methodological issues.

Sounds4Coma proposes to build on recent advances in data-driven system-identification methods (reverse-correlation) to engineer sound stimuli that are optimized and personalized for coma patients, and combine them with scalp and intracranial electroencephalography (S/EEG) to discover novel neural markers of covert auditory consciousness in healthy participants and patients, thus improving the precision of consciousness diagnosis.

Collaboration with Prof. Martine Gavaret and Prof. Tarek Sharshar (GHU Paris Neurosciences et Psychiatrie, Hôpital Sainte-Anne, Paris).



DURATION

2020-2025

FUNDING

100k€ (PhD Fellowship, Dr Estelle Pruvost-Robieux, 2020-2023); 60k€ (Fondation Gueules Cassées, 2020); 300k€ (GHU,internal funding, 2021); 960k€ (submitted, ANR-DGOS, 2021)

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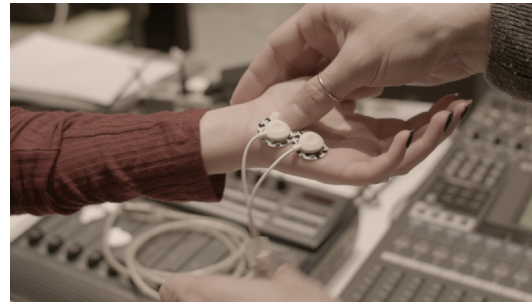
TRAUMACOUSTIK

EMOTIONAL VOCAL FEEDBACK FOR THE REHABILITATION OF POST-TRAUMATIC STRESS DISORDERS

The theory of peripheral emotional feedback – that our emotional experiences are under the retroactive influence of our own expressions – has been an ongoing subject of debate in psychology since Charles Darwin and William James in the 19th century. On the one hand, the fact that putting on a smile or a frown may have an automatic effect in one's emotional experience holds tremendous potential for clinical remediation in psychiatric disorders (an estimated 40-75% of which are linked to problems of emotional regulation). On the other hand, the idea faces tremendous methodological challenges.

Project Traumacoustik aims to build novel health technology able to channel the psychological mechanism of vocal emotional feedback for clinical application to post-traumatic stress disorders (PTSD). The project, first, aims to identify biomarkers of symptom severity in the voice of PTSD patients while they retell their traumatic event in the context of re-exposition therapy (the current clinical gold standard). Second, the project will build real-time voice transformation algorithms able to correct for these acoustic characteristics in the voice of patients, and use them in real-time vocal feedback paradigms to test their effect in improving the outcome and the acceptability of therapy.

Collaboration with Prof. Guillaume Vaiva (Centre National de Ressources et de Résilience, CN2R, Lille University Hospital, France).



DURATION

2017-2024

FUNDING

780 k€ (ANR REFLETS,CN2R, Japanese Society for the Promotion of Science Summer Program, 2021)

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WAVE

NEW BIOMARKERS OF SURGICAL ANXIETY USING PATIENT VOICE ANALYSIS AND VOICE PERCEPTION

Recent European guidelines in anaesthesia recommend systematic pre-operative anxiety management to prevent its negative peri-operative impact, including impaired memorization of important instructions and higher incidence of post-operative acute and chronic pain. Usual self-administered questionnaires or scales to assess anxiety in the preoperative setting are time-consuming and rely on the patients' willingness to comply with instructions.

Project WAVE proposes to develop new biomarkers for anxiety assessment before surgery, first, by looking for acoustic correlates of anxiety in patients' voices recorded during admission interviews on the day of surgery and, second, by looking at reaction times of patients reacting to highly-emotional voice samples.

Collaboration with Dr Laurent Guerrier (APHP, Hôpital Cochin), Dr Fabrice Vallée and Dr Stefano Arrigoni (APHP, Hôpital Lariboisière, Paris).

DURATION

2018-2022

FUNDING

70k€ (ANR, APHP)

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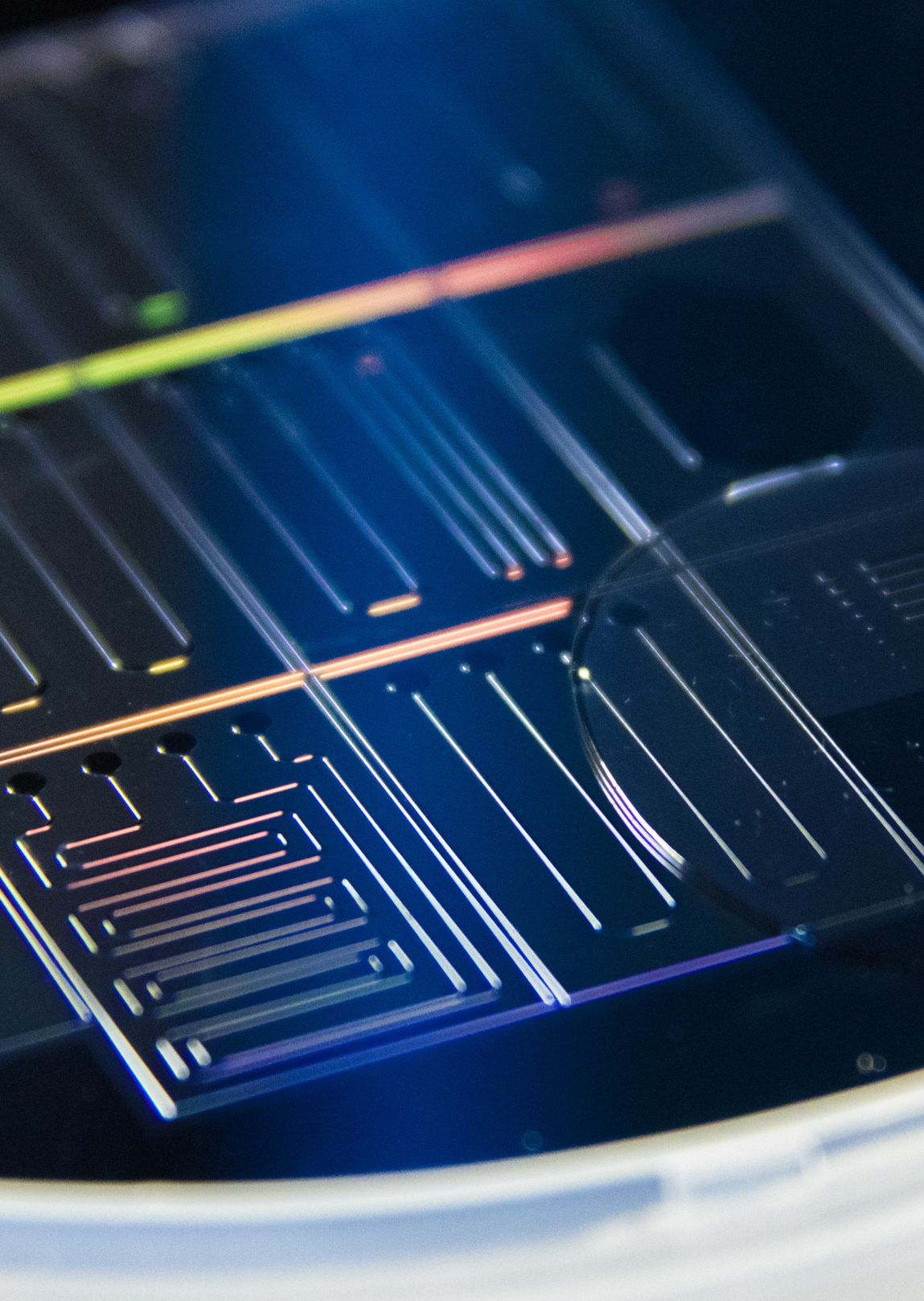

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Biom'@x

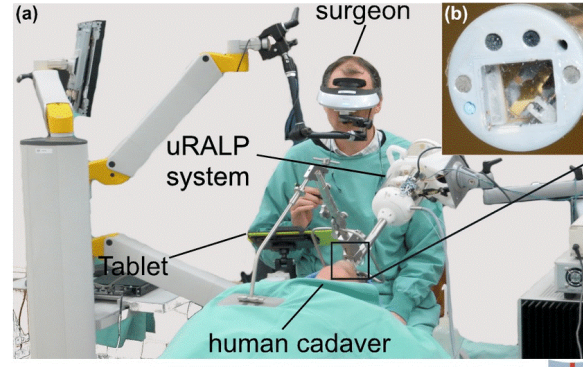
PAST PROJECTS

µRALP

MICRO-TECHNOLOGIES AND SYSTEMS FOR ROBOT-ASSISTED LASER PHONOMICROSURGERY

Lasers form an increasingly common tool for precision treatment of pathological conditions on delicate and vital human organs such as the vocal folds. However, laser aiming control still relies completely on the dexterity of surgeons who must operate through a microscope and deals with its associated poor ergonomics. This can have a strong impact on the quality of the procedures. Additionally, in laser phonomicrosurgery, the laser beam is directed from a comparatively large range (400mm), resulting in accuracy and consistency problems that require extensive surgeon training.

In this project a redesign of the surgical setup is proposed to create an advanced micro-surgical system that will allow unprecedented levels of accessibility, controllability, precision and safety during these procedures, resulting in enhanced surgical and patient outcomes. The new technologies developed herein will pave the way towards new and safer minimally invasive laser microsurgeries, leading to a significantly enhanced capacity for cancer treatment in general.



DURATION

2012 - 2015

FUNDING

2.6 M€ (FP7 European project)
60k€ (Internal Project Call at Besançon University Hospital)

CONTACT

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ABORDAGE

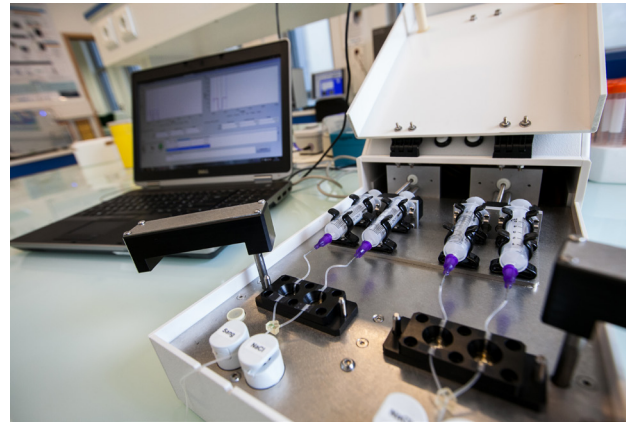
OPTICAL DETECTION OF RED BLOOD CELLS CAPTURED ON BIOCHIPS FOR RH1 COMPATIBILITY CONTROL AT THE PATIENT'S BEDSIDE

Rhesus antigen are very immunogenic and can lead to a rhesus incompatibility (RH1 also known as D antigen). Rhesus incompatibility is the result of 2 main mechanisms. The first concerns RH-1 pregnant women in contact with RH1 red cells of her fetus. In this case RH incompatibility results in an anemia (moderate to severe) or leads to the *in utero* death of the fetus. The second results from a RH1 incompatible transfusion.

In France, an ABO compatibility test is performed before each red cells concentrate transfusion at the patient's bed side. However, RH compatibility is not checked.

During the SmarTTransfuser project, we developed both biochips and an optical medical device used to automatically perform an ABO compatibility test at the patient's bed. Based on this project, ABORDAGE aims at developing an immuno-biochip able to specifically capture red cells according to their rhesus status. Again, the device is automated and can be used at the patient's bed.

ABORDAGE project is led by the Clinical Investigation Center at Besançon University Hospital in collaboration with FEMTO-ST and the Etablissement Français du Sang Bourgogne Franche-Comté.



DURATION

2013-2015

FUNDING

60k€ (Internal Project Call at Besançon University Hospital:)

CONTACT

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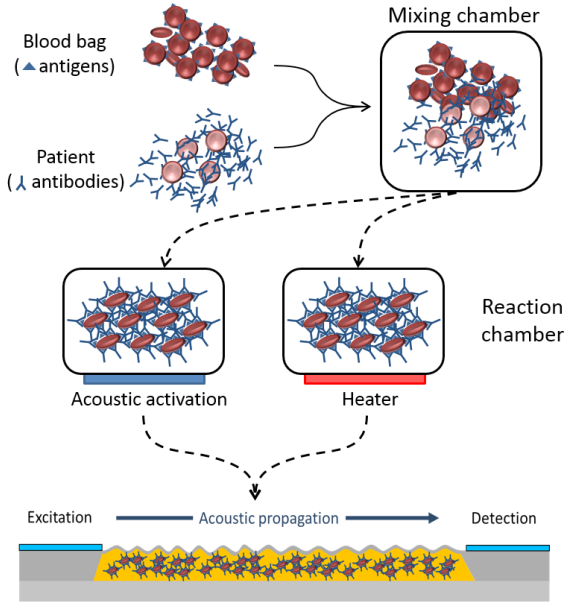
Acousto Blood

ACOUSTO-FLUIDIC DETECTION OF THE COMPATIBILITY BETWEEN RED CELL CONCENTRATES AND PATIENTS DURING BLOOD TRANSFUSIONS

During transfusions, blood incompatibilities may lead to severe or lethal consequences. Today, there exists no technique able to account for all incompatibility situations. To summarize, whatever the situation is, when incompatibility occurs, patient's antibodies destroy the red cells concentrate being transfused. In all cases, mechanical properties of red cells are modified when an incompatibility occurs. The goal of AcoustoBlood is to mix red cells to be transfused and patient's blood in an acousto-fluidic microsystem. A possible modification of the mechanical properties of red cells (due to incompatibility) leads to variations of the rheological properties of the mixture. These variations are detected by means of an acoustic sensor. All cases of incompatibility should then be addressed.



DURATION

2017 - 2018

FUNDING

12k€ (CNRS PEPS Projects)

CONTACT

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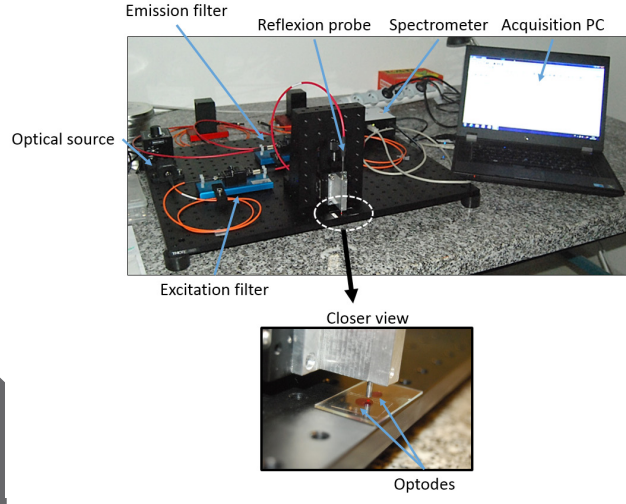
ALiBi

FLUORESCENCE AND COLORIMETRIC DETECTION Li^+ USING OPTODES TECHNOLOGIES

Bipolar disorders are a major cause of suicide in youg adults. 1/3 of patients under lithium treatment show impressive improvements of their mental health. 1/3 show no response to the treatment. For others the poor adherence to treatment may be the cause of an apparent non-response to lithium therapy.

ALiBi aims at improving the adherence to treatment by proposing a self-monitoring device to patients. Lithium levels will be measured in saliva. Optical methods based on optodes and using either fluorescence or colorimetry can potentially be used to this end.

Here, we study the physical-chemical characteristics of different optodes configurations. At the end of the project, the most promising technology which can be translated for use at home will be identified.



DURATION

2017 - 2018

FUNDING

14k€ (CNRS PEPS Projects)

CONTACT

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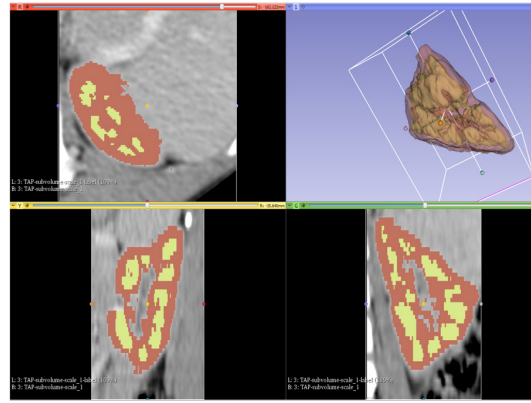
ASKid

AUTOMATIC SEGMENTATION TUMOURS IN CHILDREN USING ARTIFICIAL INTELLIGENCE OF KIDNEY

Nephroblastoma is a cancer disease for which diagnosis, surgery decision and planification are based on imagery exclusively. 3D reconstructions allow surgeons obtaining a representation of the volumes of the different structures around the kidneys, the kidneys themselves and the tumour. This 3D reconstruction requires segmentations of all the scans of the patient abdomen (more or less 250 images). The problem is that the actual segmentation tools require the help and the expertise of surgeons in order to be accurate enough. Thus, this semi-automatic step is time-consuming (11 hours for one patient) and, as a consequence, surgeons usually do not take the time to create 3D representations and base their diagnosis, interpretation and planification using only 2D scans.

The difficulty and imprecision of the automatisation of this segmentation step increases with children which do not have fat that clearly separates tumours and muscles.

The main objective of this project is to explore the possibility to enhance a segmentation method (growing region) with Case-Based Reasoning which is an Artificial Intelligence tool. We hope this tool will be able to introduce knowledge and experience to the actual segmentation process in order to build 3D representations without any human intervention.



DURATION

2016 - 2017

FUNDING

14k€ (Cancéropôle Grand-Est)

CONTACT

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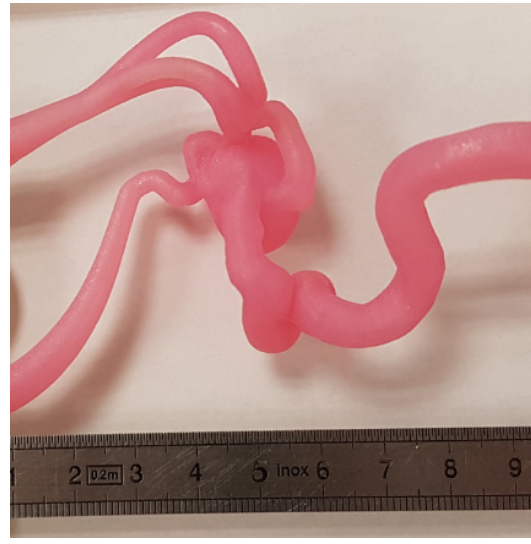
CAPTANEV

DEVELOPMENT OF AN INSTRUMENTED INTRACRANIAL ANEURYSM DEMONSTRATOR

The exponential evolution of minimally invasive treatments for neurovascular diseases, in particular intracranial aneurysms, has allowed the development of several types of endovascular devices which are convenient in case of this pathology for a personalized surgical approach. The hemodynamic phenomena observed following the implantation of the medical devices are still poorly known and nevertheless necessary to facilitate the informed choice of the implanting device adapted to the medical context of each patient.

The project involves developing an experimental test bench for the characterization of various surgical materials. It is a collaboration between the University Bourgogne Franche-Comté, the Franche-Comté biomedical engineering school of the University of Franche-Comté (ISIFC) and FEMTO-ST (department of applied mechanics – AEH team).



DURATION

2017

FUNDING

1.5k€ (INTERREG European Project)

CONTACT

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CARMEO

DEVELOPMENT OF A DEVICE TO STUDY THE MECHANICAL PROPERTIES OF HUMAN OOCYTES

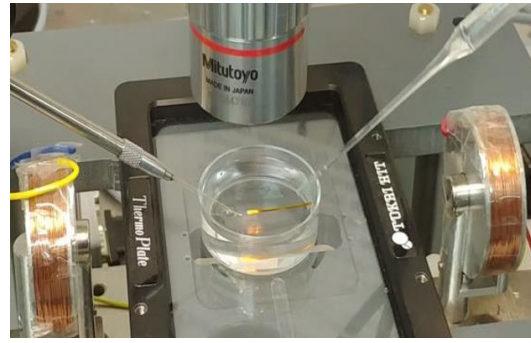
This project is focused on the development of an experimental platform that is dedicated to the mechanical characterization of human oocytes.

This project is in line with the development of medical devices that are smart systems meant to help evaluation of biological systems at the cellular level. CARMEO is focused on in vitro qualification of navigating cells like human oocytes. Mainly two research axes are studied:

- Study and modeling of the mechanical behavior of human oocytes using a nanoforce measurement platform previously developed at the AS2M department of FEMTO-ST.

- Development of a new nanoforce sensor which can be integrated in a regular equipment used for intracytoplasmic sperm injection (ICSI) and which obeys constraints imposed by the Biomedicine Agency concerning medically assisted procreation (notably disposable indentors with no gametotoxicity).

This new sensing device is based on an innovative passive magnetic nanoforce sensor that uses an autostabilized magnetic spring. This development was done in collaboration with the Clinical Investigation Center (CIC 1431) at Besançon University Hospital and was supported by the Franche-Comté council.



DURATION AND AMOUNT FUNDED:
2013 - 2015

FUNDING
36k€ (Franche-Comté region)
+Phd grant

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CAVEOTANK

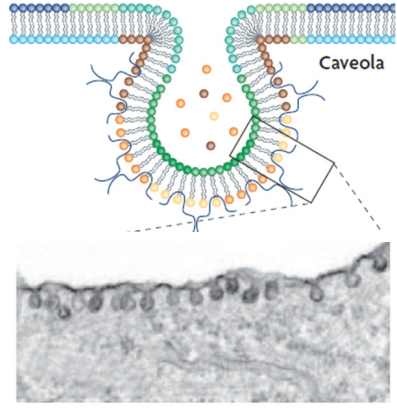
PRODUCTION OF RECOMBINANT MEMBRANE PROTEINS EMBEDDED IN HETEROLOGOUS CAVEOLAE

Caveolae to evaluate whether sub-microvesicles can improve the production and characterization of membrane proteins (MPs).

MPs encoded by 25 % of human genome play crucial functions in a wide variety of cellular processes. They are involved in numerous pathologies and therefore represent important drug targets. Nevertheless, their overexpression in heterologous systems, required for detailed structural and functional analysis, encounters numerous obstacles (toxicity towards hosts, quality of the MP produced).

The original approach is to produce MP-enriched sub-microvesicles using the ability of a small MP to generate vesicles within the cytoplasm in various hosts. The final objective is to facilitate MP functional and structural characterization. The production, already observed in *Escherichia coli* bacteria and Sf21 insect cells, will be tested into two other organisms: the bacteria *Lactococcus lactis* and the parasite *Leishmania tarentolae*, for 3 human MPs of high pharmaceutical interest.

This project, supported by the I2BC Institute (Saclay), is based on the close collaboration of 3 laboratories (I2BC/LPSM (Saclay), IBCP/MMSB (Lyon) and FEMTO-ST (Besançon)) with complementary knowledge and know-how in the different institutions (in particular the BMD group at FEMTO-ST for its unique expertise in MP characterization in *L. lactis*) as well as in the functional and structural analysis of the 3 MPs.



DURATION

2017 - 2020

FUNDING

346k€ (French National Research Agency)

CONTACT

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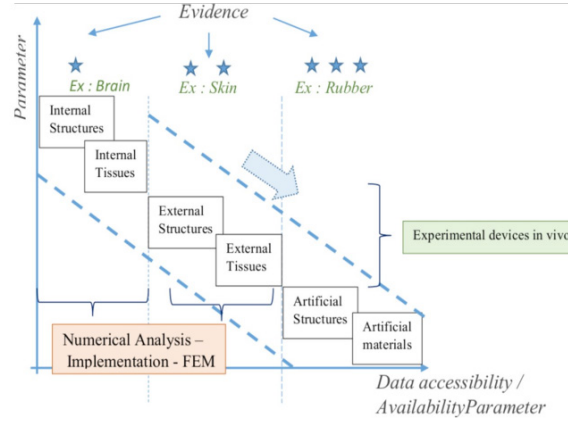
CLUE

CLINICAL UNCERTAINTY QUANTIFICATION IN SOFT TISSUE BIOMECHANICS

The project will deliver error-controlled algorithms enabling the biomechanics community to select the most suitable constitutive model for soft tissues or phantoms, identify their parameters, assess the uncertainty of this model on the parameters and give clues on optimal experimental design to minimize uncertainty. *In vitro* tests and clinical trials in dermatology will be planned. The project involves implementing models and validation based on experiments with high-variability of parameters and unknown boundary conditions. Open-source algorithms will be implemented in widely distributed software (FEniCS). The medical, practical and societal impact will come from quantitative tools for diagnostic and medical examination planning designed collaboratively with end-users such as surgeons or biomedical designers.

The University of Luxembourg (LEGATO team) and the University Bourgogne Franche-Comté (Laboratoire de Mathématiques de Besançon and FEMTO-ST/Department of Applied Mechanics, AEH team) collaborate around three axes: error quantification to choose the best approximation, numerical methods to optimize the way to simulate reality and experimental approach to compare reality and virtual results.



DURATION

2018

FUNDING

48k€ (Bourgogne-Franche-Comté Council)

CONTACT

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CO3SENS

SMARTY

ENVIRONMENT TOXIC GASES MONITORING: CARBON MONOXIDE (CO) DETECTION (CO3SENS) AND FORMALDEHYDE (SMARTY)

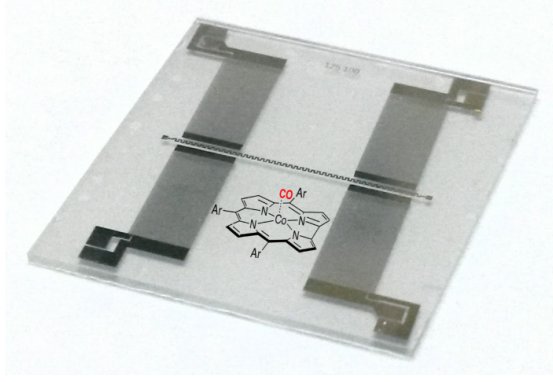
Our environment is composed of numerous nano particles suspended in the air. Carbon monoxide is a colorless, scentless and toxic gas which can be produced by the combustion of any organic matter, in particular when oxygenation is not sufficient. Aldehydes are also considered hazardous gases. Therefore, there is a need for sensors able to detect the presence of these molecules in the air at low concentrations.

In these projects, specific functionalizations based on cobalt metallocorroles and sol-gel are developed to selectively coordinate carbon monoxide and capture formaldehyde in ambient air.

These sensitive layers, combined with a device based on surface acoustic waves, allow a very high sensitivity to these toxic gases.

Indeed, by capturing these molecules, the mass of the sensitive layer increases. This mass variation can be measured by the sensor and therefore be related the targeted gas concentration with a great sensitivity up to a few ppb.

This research consists of the development of a device able to perform precise detection of low variations of gas molecules present in the air, in particular carbon monoxide and formaldehyde.



DURATION

2015 - 2018

FUNDING

250k€ (French National Research Agency)

CONTACT

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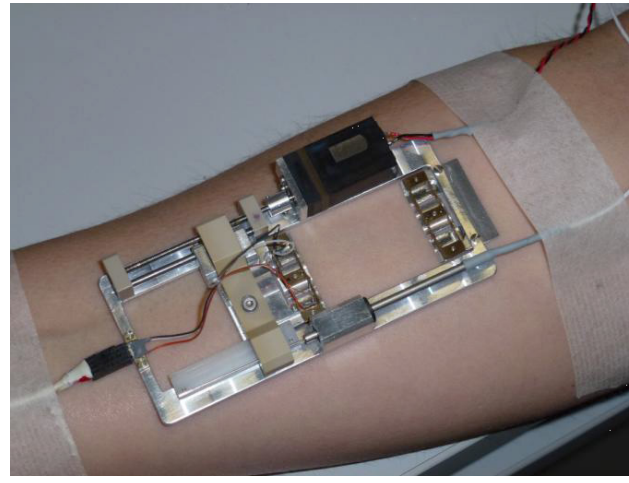
Derm'@x

SKIN PROPERTIES, MULTI-SCALE ANALYSES

The first objective of Derm'@x consists in studying the properties of the skin under a multi-modal approach « biomechanics-biophotonics ».

This multi-modal approach also benefits from computing sciences and image stitching.

The second objective consists in going furhter in the understanding the skin properties by starting studies involving functionalized local optical probes which allow simultaneously recording topology and ionic concentrations at the surface and between cells in culture. The ulterior motive concerns how mechnical sollicitations influences the skin at a cellular level.



DURATION

2014-2015

FUNDING

617k€ (FEDER European Project)

CONTACT

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DICODERM

COLLABORATIVE DIAGNOSIS OF TUMORAL DERMATOSIS

The project consists in designing an optical probe for the detection of skin cancers. This probe is linked to sets of dedicated images and a secured and collaborative analysis. The objective is to propose a reliable tool of collaborative surveillance of the evolution of a tumoral dermatosis. The probe exploits one of the characteristics of tumoral cells: the important concentration of protoporphyn. The auto-fluorescence of the cells for which the protoporphyn rate is high allows early detecting tumours.

The probe allows a double acquisistion of white light and auto-fluorescence. The combination of both principles gives the opportunity to match the fonctional image onto the anatomic one. After the acquisitions, it is necessary to compute the positioning of each pair of images (the one in white light and the one in fluorescence). The extraction of characteristic points is performed over white light images since it is easier and more efficient than over fuorescent images. The positioning parameters describe the transformation (rotation, translation, scale, etc.) and they are used to create the final panoramic image (fluorescence).

DURATION
2009 - 2015

FUNDING
50k€ (Franche-Comté Council)

CONTACT
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EPOMCET

STUDY OF INNOVATIVE DEVICES FOR THE MEASUREMENT OF OPTO-MECHANICAL PROPERTIES IN TISSUE AND CELLULAR BIOLOGY

Objective discriminations between healthy cells / pathological cells and healthy tissues. Innovative methods have been developed in the following areas:

1. Absorption and fluorescence spectrometry,
2. OCT optical coherence tomography,
3. Multispectral Imaging,
4. Tissue mechanics.

The overall study was structured into two main research axes, evaluation of the physical and mechanical properties of cells and tissues, in order to define biological parameters characteristics of living organisms. The analysis of optical properties of the cells has been carried out, starting from the observation that certain specific proteins (porphyrins, Cd137, ...) are stored in greater quantities in cancer cells and are possibly capable of autofluorescing. A spectroscopic optical system and a Scan Free OCT reference OCT system were developed as well as two polarization optical characterization benches to identify pathological dyphasic tissues. The mechanical properties of cutaneous tissues were evaluated experimentally on the basis of uniaxial and biaxial harmonic stress tests.

Into FEMTO-ST Institute, the departments DISC, DO et DMA have collaborated in this project.

DURATION

2010 - 2014

FUNDING

107k€ (Franche-Comté Council)
PhD Grant (Ministry of Research)

CONTACT

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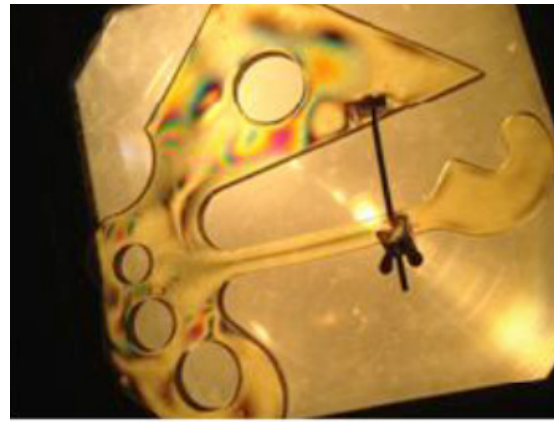


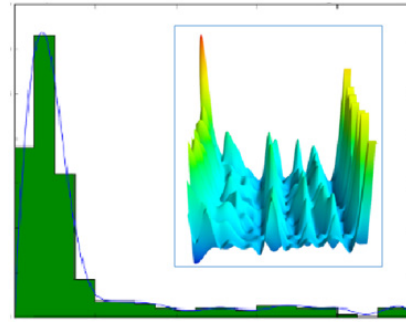
ET

MODELING OF TRANSPOSABLE ELEMENTS

The ET project (transposable elements) is a multidisciplinary study aiming at investigating the mathematical and computer modelling of the movement of transposable elements in genomes. These transposable elements have been studied for more than 60 years but have never, or almost never, been modeled. Describing their dynamics, changes in the number of copies, places of insertion, and the degradation of ETs could, however, be important in the fight against diseases more or less directly related to these ETs: Duchenne muscular dystrophy, hemophilia, cancers of the oesophagus, breast or reproductive organs.

It is therefore becoming clear that understanding the evolution of genomes and pathologies cannot be achieved without taking an interest in the dynamics of ET. A collaboration between mathematicians, computer scientists and biologists has been set up to describe and predict the evolution of transposable elements, based on sequencing data from past and present organizations. These models are intended to describe the transposition of the ETs at transposon level (cut and paste type movement). They involve discrete dynamic systems, Markov chains (hidden on trees), Bayesian inference, and partial differential equations.

The project is a collaboration between the Chrono-environnement laboratory, the Besançon Mathematics Laboratory and FEMTO-ST.



DURATION

2013 -2015

FUNDING

60k€ (Internal Project Call at Besançon University Hospital)

CONTACT

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FluoroCorde

FLUORESCENCE SPECTROSCOPY FOR THE DIAGNOSIS OF VOCAL FOLDS CANCERS

Non-invasive methods to descriminate healthy from pathologic tissues is a key issue, especially in cancerology. Fluorescence imaging based on tissue autofluorescence is an advanced and non-invasive imaging technique and allows visualizing zones considered as pathologic.

Given the main proteins present in healthy or pathological tissues (porphyrin, collagen, flavin, NADH, elastine...) the goal of FluoroCorde is to study the autofluorescence properties of these tissues when they are excited with wavelengths which correspond to these proteins as it was shown in other tissues than vocal folds.

Fluorescence spectra obtained on biopsies are analyzed using statistical classification methods in order to discriminate the various benign or pathologic nature of the biopsies.

DURATION

2015 - 2017

FUNDING

Clinical Trial of the µRALP Project

CONTACT

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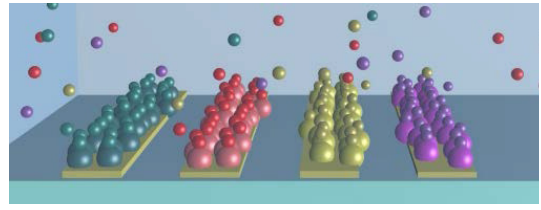
MADNESS

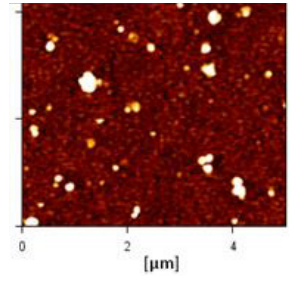
A GENERIC MICROFLUIDIC APPROACH FOR DECIPHERING NANOSCALE BIOVESICLES PROPERTIES

The overall objective of MADNESS project is to develop a miniaturized conceptual platform allowing the isolation, fractionation and classification of Extracellular Vesicles. We propose a microfluidic approach coupling a hydrodynamic separation module with analysis and reaction chambers. The microfluidic module will perform size fractionation within the 100-500 nm range where flow cytometers cannot operate. In front of each collecting chambers, we envision to interconnect miniaturized immuno (and ligands)-µarray in microchannels in order to perform specific captures in a multiplex format followed by nanometrological investigation of trapped species with an AFM instrumentation.

Then, each fractionated sample will be collected in order to be quantified and qualified with multi-omics approaches by coupling mass spectrometers available in our instrumental park.

Although this project focusses on instrumental issues, we propose to make the proof of concept on the representative case of platelet microvesicles (PMVs). Depending on the stimulus responsible for their production, PMVs exert different biological functions (*i.e.*, capacity to stimulate or not endothelial cells, dendritic cells). This will be used as a functional read-out to analysed fractioned PMV samples. This multiparametric and multifunctional approach will pave the way to a generic instrumentation for bio-nanoparticles qualification enabling new diagnostic/ prognostic assays.





DURATION

2017 - 2020

FUNDING

358k€ (French National Research Agency)

CONTACT

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MECAPELVIS

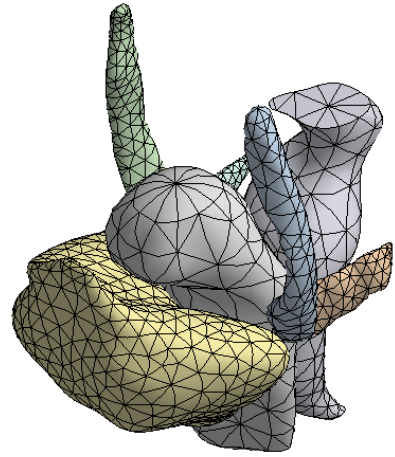
BIOMECHANICAL STUDY OF STRATEGIES FOR SURGICAL CORRECTION OF PELVIS PROLAPSE

Prolapse (a loosening of the organ) is a disease that affects one woman in three, and more than 60% of patients over 60 years. However, its causes and origins are poorly known. The project consisted of the development of a personalized numerical model representative of the pelvic region including the uterus, bladder, colon, ligaments. The geometry was obtained from images of patients with disorders requiring surgery. The mechanical properties of the tissues, stresses and boundary conditions were chosen from bibliographic data.

Numerical simulations of the response of the pelvic region to the conditions of an abdominal cough made possible quantifying the finite element model sensitivity to the mechanical parameters. A reference configuration was chosen from a simplified model (linear elastic, localized loading and contact management).

The objective was to evaluate the incidence of hysterectomy in the treatment of prolapse pathology. The development of a personalized model can be a decision-making tool for the obstetrician surgeon.

The project is a collaboration in the University Bourgogne Franche-comté, between the FEMTO-ST Institute (department of applied mechanics – AEH team), the Obstetric Surgery and Anatomy Laboratory of the university hospital (CHRU) and the Mecanique and Microtechniques National Engineering School (ENSMM) and the Master of Mechanical Engineering of the University of Franche-Comté.



DURATION

2014 - 2015

FUNDING

6k€ (Besançon University Hospital and FEDER)

CONTACT

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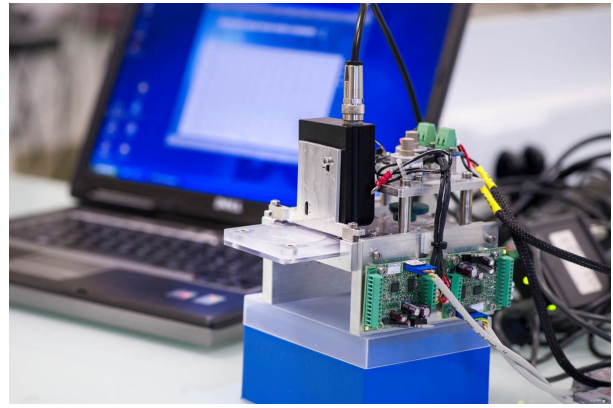
MEDICALIP

SCREENING THE CYTOMEGALOVIRUS AT BIRTH

Cytomegalovirus infection of newborns can lead to late clinical consequences and severe neurologic effects. An early detection of infected newborns would allow medical staff to follow infants and to manage them as soon as possible. Therefore, a rapid diagnostic tool which can be used at the newborn's bed is required and would constitute a major advance compared to current techniques. Nowadays and when it is performed, diagnosis is based on cell culture or PCR. These techniques require sampling urine or saliva from newborns, conserving samples and sending them to specialized biology laboratories. Furthermore, a large amount of biological samples must be obtained to perform tests.

In MEDICALIP project, we developed an automated microsystem used to detect cytomegalovirus by means of a specifically designed biochip.



DURATION

2007 - 2009

FUNDING

511k€ (French National Research Agency)

CONTACT

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MELpH

FIBER OPTIC pH SENSOR USING FLUORESCENCE PROPERTIES OF SNARF AND FLUORESCEIN

Organic functions of the human body are linked to biological constants. Variations of these constants induce pathological troubles. Among these constants, the pH is the central subject of this Ph.D. work. In living beings, biological functions are related to either acid or alkaline constants. Indeed, the action of a protein depends on the surrounding pH. An inadequate value of the pH makes the proteins non active which is deleterious for the organism. There exists a need for pH sensors which can be used in the human body for clinical applications (macroscopic scale), on cells in culture for biology researches (mesoscopic scale) or at a cell membrane level for more fundamental studies (microscopic scale). Among the wide range of technologies potentially useful for these applications, fiber optic fluorescence pH sensing offers the possibility to be adapted to the three above mentioned dimensional scales. This Ph.D. dissertation addresses these constraints by studying fluorescence fiber optics pH sensors using two kind of pH indicators: SNARF and fluorescein. Together with these experimental studies, mathematical descriptions of the fluorescence properties of these indicators are proposed. They allow progressing towards calibration free pH sensing.

DURATION
2013-2017

FUNDING
5k€ (Optics and Photonics Network)
PhD Grant (Government of Thailand)

CONTACT
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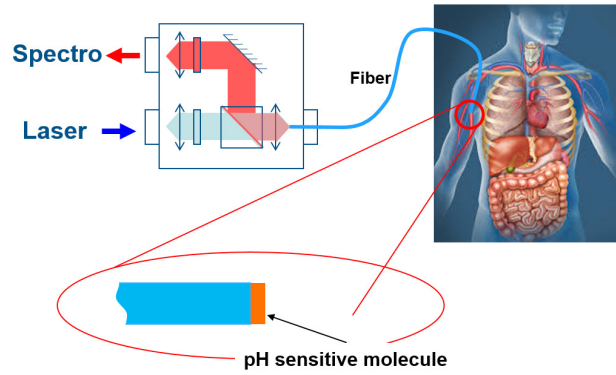


NBA-QuaVEs

A NANOBIOANALYTICAL PLATFORM FOR THE QUALIFICATION OF EXTRACELLULAR VESICLES

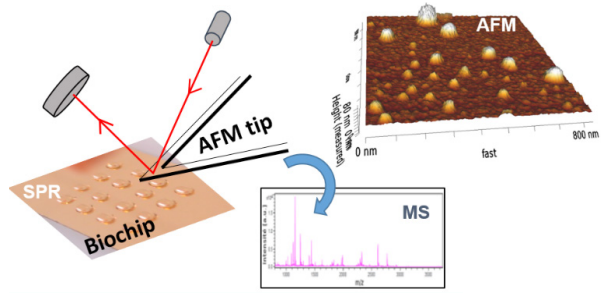
Extracellular vesicles (EVs) are produced by the majority of cell types. They are released into the extracellular space and found in the various physiological fluids of the human body (plasma, saliva, urine, cerebrospinal fluid, etc ...) following activation or apoptosis of these cells. These vesicles are currently recognized to participate in various (patho-) physiological processes but also as biomarkers of different pathologies. Although the study of these vesicles has become increasingly interesting in recent years, it has been hampered by limitations in isolation, purification, and fine characterization techniques that allow accessing to their concentration, phenotyping, and size.

In this EVs context, we propose the development of a NanoBioAnalytic platform (NBA), the fruit of a combination of several technologies, to access this triptych concentration / phenotyping / size of EVs (Obeid S. et al , Biosens, Bioelec, 2017 Jul 15, 93: 250-259).

Today, developments are focused on the evolution of this NBA platform, in particular:

- in the development of a microfluidic sorting module according to size (collaboration with LAAS, Toulouse, Dr AM Gué),

- on-line monitoring of the production of EVs in bioreactors by cancer cells in contact with blood cells (collaboration with Tapei Medical University, Taiwan, Pr T. Burnouf).



DURATION

2017 - 2020

FUNDING

19k€ (CNRS)

123k€ (Franche-Comté Council PhD Grant)

CONTACT

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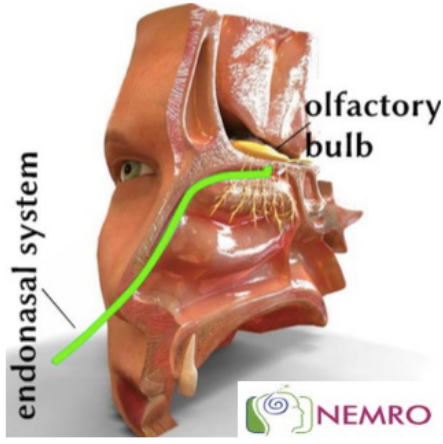
NEMRO

MICROROBOTIC NASAL ENDOSCOPY BY OCT: IMPACT OF SMELL DEFICIENCY ON NEURODEGENERATIVE DISEASES

NEMRO refers to a transdisciplinarity and fundamental research project. It grounds itself in Engineering and Information Science (microrobotics) but with a strong anchor into the medical field (neurosciences). NEMRO addresses a wide research field, with both scientific and technological ambition, as well as a clear clinical application: neurodegenerative diseases (Alzheimer, Parkinson) and other pathologies with similar effects (drug addiction).

Although this field has been widely studied, our approach is in total shift with the state-of-the-art and the state of clinical practice in the field. It relies on the recent finding of a strong correlation between the olfactory system deficiency and the appearance of the first symptoms of neuronal degeneracy. With NEMRO, clinicians will be given unprecedented technical means for *in vivo* investigation, characterization and, hopefully, *in situ* stimulation of olfactory cells, thanks to an Optical Coherence Tomography (OCT) miniature probe, steered and positioned accurately by a microrobotic flexible structure.



DURATION

2015 - 2019

FUNDING

498k€ (French National Research Agency)

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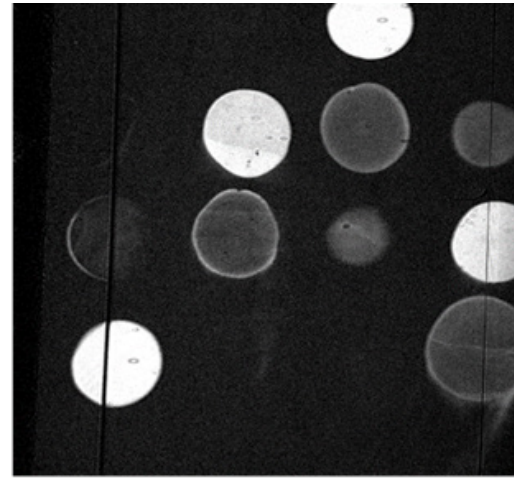
NEOTAG

AUTOMATED DOSAGE FOR 3 PATHOLOGIES OF THE FRENCH PROGRAM OF NEONATAL SCREENING

Co-certified by the Pole of Microtechnics and the Nutrition Health Longevity's Pole, the Neotag project has for objective to create a solution of an automated dosage for three pathologies which are in the French program of neonatal screening using the Mass-Plex Technonology of the Imabiotech company (Lille).

The development of theses dosage kits will allow an improving screening and investigation of metabolic dysfonctions by decreasing the time of analysis, reducing the number of samples while allowing a better reliability of theses analysis.



DURATION

2014 - 2017

FUNDING

2M€ (FUI Project)

CONTACT

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P'AIR

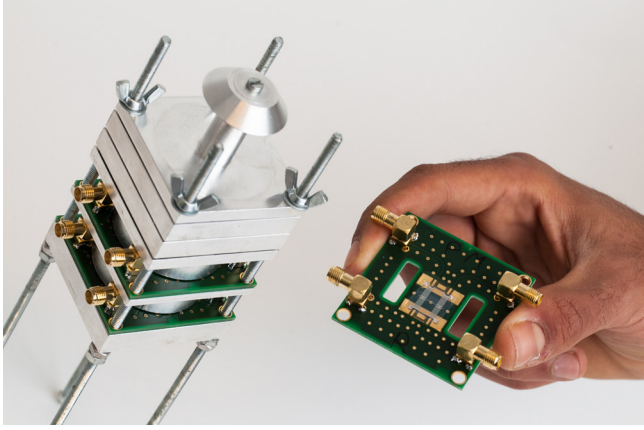
SURFACE ACOUSTIC WAVES SENSORS FOR THE MEASUREMENT OF FINE PARTICLES CONCENTRATION IN THE AIR

Nowadays, atmospheric pollution is becoming a health issue. Among different pollutants, particles matter (PM) are considered as the most threatening for human health. More specifically, particles called PM10 and PM2.5, corresponding respectively to those exhibiting an aerodynamic diameter smaller than 10 and 2.5 µm, can deeply penetrate the human lungs. More than 2 millions premature deaths are caused by air pollution according to the World Health Organization (WHO).

This project aims at developing a tool to perform PM2.5 and PM10 concentration measurements based on acoustic waves sensors.

This research was funded by an industrial scholarship (CIFRE) within a partnership between FEMTO-ST and the company Ecologicsense. It was undertaken in the framework of the P'AIR (Particle Atmospheric Intelligent Research) project, which aims at developing a network of new innovative low cost sensors in order to create a pollution map of a city.

To achieve this, a device based on Surface Acoustic Waves (SAW) sensors combined with a cascade impactor was developed. A prototype, operating at 3~Lpm, was built during this research and its ability to separate and measure PM2.5 and PM10 particles in real time was demonstrated. This innovative combination SAW/impactor led to a patent in April 2016.



DURATION
2013-2017

FUNDING
220k€ (FUI Project)

CONTACT
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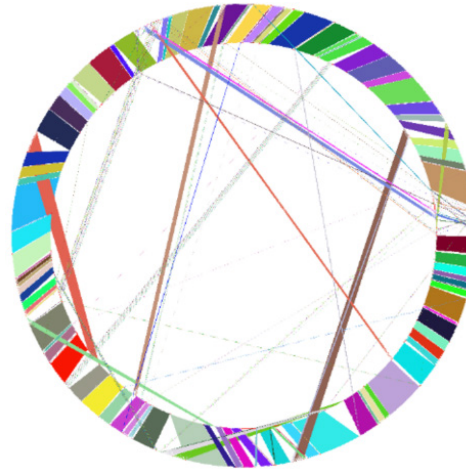
PEG

PREDICTION OF GENOME EVOLUTION

The PEG (Prediction of Genome Evolution) project is a multidisciplinary project aiming at modeling the evolution mechanisms of DNA sequences. This project is based on skills and themes that have been developed over many years (work on predictive models for protein evolution), and others more recently installed at the University of Franche-Comté within the framework of CRNS/UFC scientific excellence chairs.

The project is divided in two parts. The first fundamental part consists of the acquisition of genetic data resulting from the study of ancient parasites (paleoparasitology). The second component and core of the project is the development of mathematical and statistical models of genome evolution. These models are intended to describe nucleotide mutations and genomic rearrangements. These two aspects of the project are closely linked in the sense that the reality of the established models can only be achieved through the study of ancient archaeological sequences.

The project is a collaboration between the Chrono-environnement laboratory, the Besançon Mathematics Laboratory and FEMTO-ST.



DURATION

2012 - 2015

FUNDING

130k€ (Franche-Comté Council)

CONTACT

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PhD Besançon Conurbation

MANAGEMENT OF CONCURRENT SOLUTIONS OVER A DISTRIBUTED PLATFORM DEDICATED TO IMAGE SEGMENTATION

Segmentation is a key-process of imagery. In the context of cancer disease, surgeons use this process in order to create 3D representations of organs and structures around them. Nevertheless, actuel segmentation algorithms are not always efficient enough, and require the expertise and experience of surgeons in order to create accurate 2D representations. Indeed, in the particular case of children affected by nephroblastoma (cancer disease of kidney), the margin between tumour and muscles are usually not found by the segmentation programs. Thus, if they want to build a 3D model of the children abdomen, surgeons must spend 11 hours or more to verify and correct the results of the segmentation of all the scans (more or less 250 per patient). As a consequence, although important for cancer diagnosis and surgery planification, this segmentation step is never performed and surgons have to interprate more than 200 2D scans directly.

Since we have identified that these segmentation process lack of experience and interpretation knowledge, we propose to enhance these processes with many Artificial intelligence tools like Deep learning and Case-based reasoning. We propose to design and implement a platform of agents that will interact with each other in order to preform in parallel and agregate concurrent segmentations to create 3D representations as accurate and consistent as possible.

DURATION
2016 - 2019

FUNDING
Besançon Conurbation
PhD Grant

CONTACT
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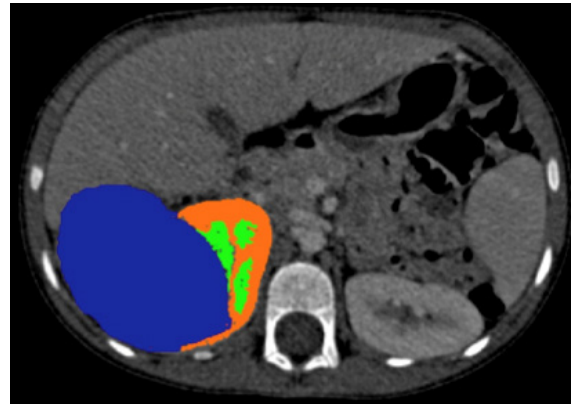


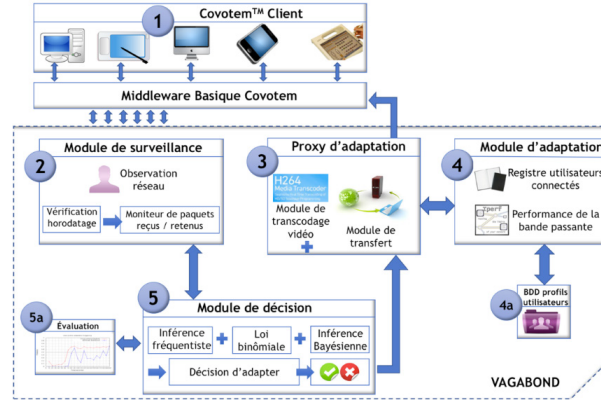
PhD with COVALIA

MULTIMEDIA FLOW ADAPTATION APPLIED TO MEDICAL TELEDIAGNOSIS

In the context of collaborative software dedicated to telemedicine, quality and reliability are of primary importance. Hence, when a doctor must establish a telediagnosis by means of audio and/or video flows, the consistency, quality and reliability of received data must be guaranteed during the entire communication session. It is also important to guarantee the continuity and the quality of service during the entire data transport.

Consequently, it is necessary to implement tools which garantee that the multimedia flow has arrived without alteration and with a quality which allow end-users to operate them.

The use of adaptation mechanisms should allow creating flows adapted to the context, to the constraints of the environment and to the requirements and preferences of the users. It is also important to be able to test these adaptation choices in real conditions.



DURATION

2014 - 2017

FUNDING

30k€ (CIFRE PhD with COVALIA)

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PhD with MAINCARE

SECURED LAYER FOR INTEROPERABILITY, COLLABORATION AND USER PROFILE MANAGEMENT FOR MOBILE APPLICATION DEDICATED TO MEDICAL TELEDIAGNOSIS

The mobility becomes a more and more frequently asked requirement for telediagnosis. In order to address this requirement, we propose a secured layer for interoperability, collaboration and user profile management for mobile medical telediagnosis. Two aspects are studied in this thesis:

- Material and equipment: considering the evolution of new terminals (smartphones for example), mobile telediagnosis becomes a reality and flows must be adapted in order to suit to terminals and networks,

- User profile: it is important to dynamically adapt the users profile to the type of terminal used and also to their real-time situation. For example, a dermatologist will need skin images (scars, tumoural dermatosis, etc.) of high quality in terms of graphical resolution and colorimetry, a neurologist will need a fluent video (24 frames/second) without resolution constraint in order to evaluate the seriousness and consequencies of a cerebrovascular accident. In addition to video streaming constraints, patient case file must be download cleverly, depending on users and use.

DURATION

2017 - 2020

FUNDING

30k€ (CIFRE PhD with MAINCARE)

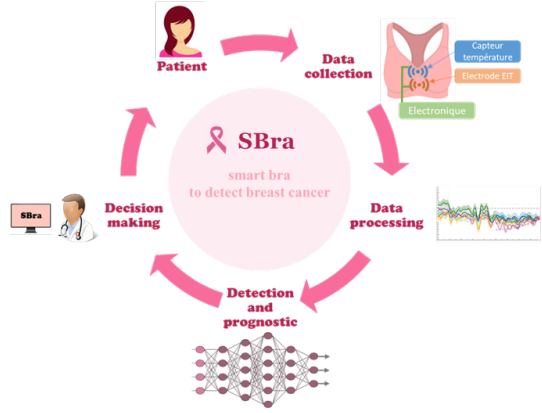
CONTACT

jc.lapayre@femto-st

SBRA

SBRA PROJECT AIMS TO DEVELOP A CONNECTED DEVICE FOR BREAST DETECTION USING ARTIFICIAL INTELLIGENCE TOOLS.

The SBRA project aims to develop a medical device for breast cancer detection. Breast cancer is the leading cancer in women worldwide with about 2 million new cases and 685,000 deaths each year. Mammography is the most widely used screening and diagnostic method. To overcome some of the disadvantages of the mammography, we propose to develop demonstrators capable of diagnosing breast cancer at an early stage. The idea is to study the feasibility of a solution combining non-invasive and non-intrusive technologies, based on the measurement of electrical and thermal properties of the mammary tissues. The smart bra is equipped with these two types of technologies and will be capable of effectively detecting an anomaly comfortably and without risk to health. This project involves several partners and it is supported by Interreg Europe. It relies on French-Swiss cooperation involving: FEMTO-ST, the Ecole Nationale Supérieure de Mécanique et des Microtechniques (ENSMM), the Hôpital Nord Franche Comté (HNFC), the Université de Technologie de Belfort-Montbéliard (UTBM), CSEM (Neuchâtel) and the company ZTC Technology (La Chaux-de-Fonds).



DURATION

2019-2020

FUNDING

991k€ (Interreg Europe)

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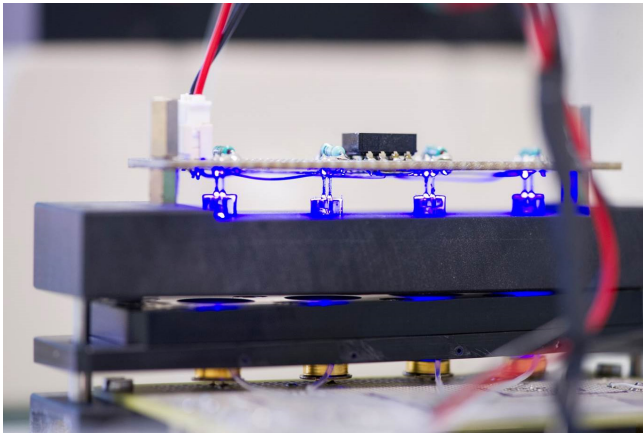
SmarT Transfuser

A SMART DEVICE FOR ABO ULTIMATE CONTROL PRIOR TO BLOOD TRANSFUSIONS

The SmarTTransfuser project is led by the Clinical Investigation Center at Besançon University Hospital and is conducted in collaboration with FEMTO-ST and the Etablissement Français du Sang Bourgogne Franche-Comté. SmarTTransfuser aimed at developping an automated and mobile device used to control the ABO compatibility between a red cells concentrate and a patient.

The concept constitutes a breakthrough with current techniques as it integrates a biochip directly in the transfusion line. This method allows performing an ABO compatibility test without any risk of blood exposure, in an automated way at the patient's bed side.



DURATION

2007 - 2011

FUNDING

350k€ (Grant from the Etablissement Français du Sang, Translational research program INSERM/DGOS, OSEO/Innovative Project Maturation)

CONTACT

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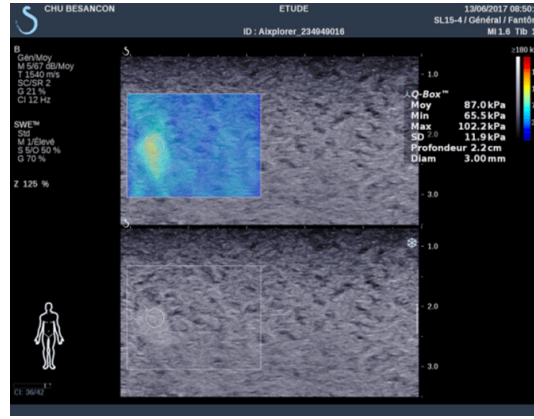
SWEP

ELASTOGRAPHY IN SOFT TISSUES

SWE elastography is a medical imaging technique that maps the elastic properties of soft tissues and allows non-invasive analysis of internal tissues. The use of this technique is progressing in the medical field to serve as a diagnostic tool in the case of some pathologies.

However, the technique is based on several assumptions which are not always relevant in the case of living tissues. In particular, living tissues generally have nonlinear (hyperelastic) viscoelastic behavior. Similarly, the supposed homogeneity of the tissues to identify a defect with abnormal mechanical behavior is not always valid.

The project consists in identifying, from a mechanical point of view, the domain of validity of the quantitative elastography technique (SWE). It is a collaboration between the University Bourgogne Franche-Comté, the gynecology-obstetric department of Besançon University Hospital (CHU), the Franche-Comté biomedical engineering school of the University of Franche-Comté and FEMTO-ST (department of applied mechanics – AEH team).



DURATION

2017

FUNDING

Auto-funding

CONTACT

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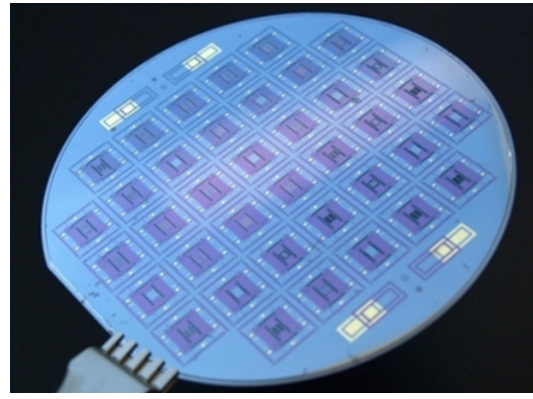
VIAMOS

VERTICALLY INTEGRATED ARRAY-TYPE MIRAU-BASED OCT SYSTEM FOR EARLY DETECTION OF SKIN PATHOLOGIES

Today, histopathology examination is the gold standard for various cutaneous pathologies. However, a large number of unnecessary surgical procedures are still performed. Consequently, new non-invasive methods such as ultrasounds, MRI or optical coherence tomography (OCT) are employed in order to perform optical biopsies of skin, improving patient's quality of life. Nevertheless, the existing bulk systems are expensive, only affordable at the hospital and thus, not sufficiently used by physicians or dermatologists as an early diagnosis tool.

The goal of VIAMOS is to benefit from advanced MOEMS technologies, enabling a new generation of miniature instruments. The challenge is to provide handheld, low-cost, fully parallel spectral domain miniature OCT devices, adapted for early diagnosis of cutaneous pathologies. For this purpose, the system is based on a matrix of Mirau interferometers fabricated by MOEMS technologies associated to electrically-pumped MEMS-VCSEL light-sources operating at 850 nm and taking advantage of polymers and semiconductors-based collective micro-nanotechnologies. Thanks to this combination, a miniature and low-cost SS-OCT imager providing cross-sectional tomograms with a depth greater than 0.5 mm, axial and transverse resolutions of 6 µm and imaging field of 8x8 mm^2, is developped.



DURATION

2012 - 2015

FUNDING

760k€ (FP7 European Project)

CONTACT

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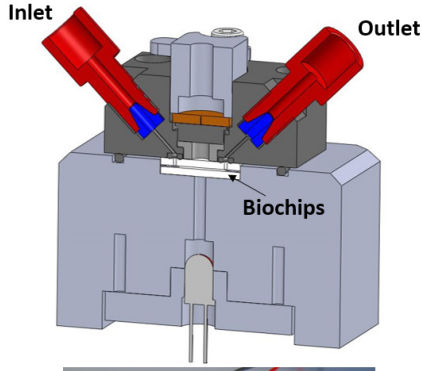
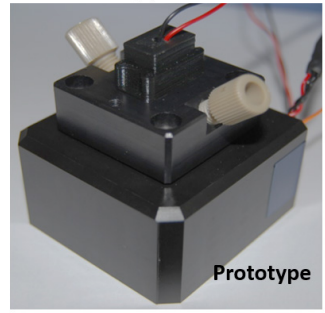
VIRUMILK

DETECTION OF CMV WITH A BIOCHIP FROM WHOLE MILK OF LACTATING MOTHER OF VERY PRETERM INFANTS

Cytomegalovirus (CMV) infaction may result from a mother-fetus transmission during the pregnancy (congenital infection) or from post-natal transmission. Currently, the viral status of the breastmilk is not cheked because of the lack of diagnosis tool which could be used on a routine basis. Clinicans face a dilemna concerning milk feeding. Either they decide to de-activate beastmilk (mainly by freesing) but they loose the interest of mother milk for infant development, or they decide to use native breastmilk with the risk of re-inforcing possible post-natal infections.

In order to help clinicians in their practice, VIRUMILK project aims at developing a rapid diagnostic test (RDT) which could be used at the hospital or at home in a self-evaluation manner. Prior to this, a technico-clinical study is ongoing to develop an integrated ELISA-like device able to detect CMV in native breastmilk.





DURATION

2017 - 2018

FUNDING

25k€ (Internal Call Besançon University Hospital)

CONTACT

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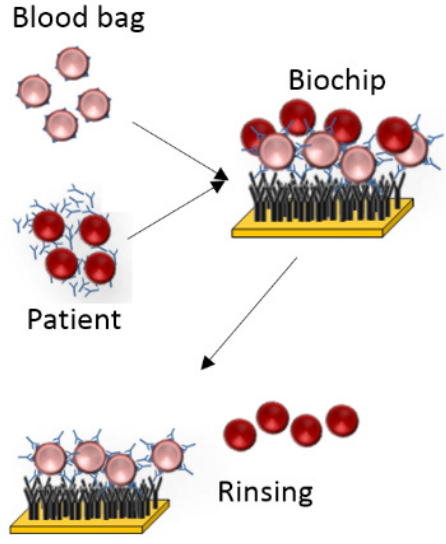
X-ult

HUMAN IMMUNOGLOBULIN COATED BIOCHIPS AND SENSITIZED RED BLOOD CELLS: TOWARDS AN INTEGRATED CROSSMATCH AT THE PATIENT'S BED SIDE

In line with SmarTTransfuser and ABORDAGE projects (ABO and RH1 compatibility), X-ult aims at developing biochips able to capture red cells sensitized by irregular antibodies. The ulterior motive is to improve transfusion safety by developing a mobile and automated device able to realize a crossmatch test at the patient's bed side. Currently, biochips technology is investigated in order to mix red cells form the blood bag and patient's blood. Specifically designed antibodies coated onto the biochip ensure specific immuno-capture of the sensitized blood bag's red cells. Proof of concept is studied using Surface Plasmon Resonance (SPR) technology. Translational research is then conducted in order to transfer SPR technology in a device where the detection of captured red cells is based on optical absorption. The device is also developed so that identito-vigilence is re-inforced and it should ideally be wirelessly connected to the hospital informatics system.

This project is led by the Etablissement Français du Sang in collaboration with FEMTO-ST and the Clinical Investigation Center (CIC 1431) at Besançon University Hospital.



DURATION
2014 - 2017

FUNDING
129k€ (French Blood Agency)

CONTACT
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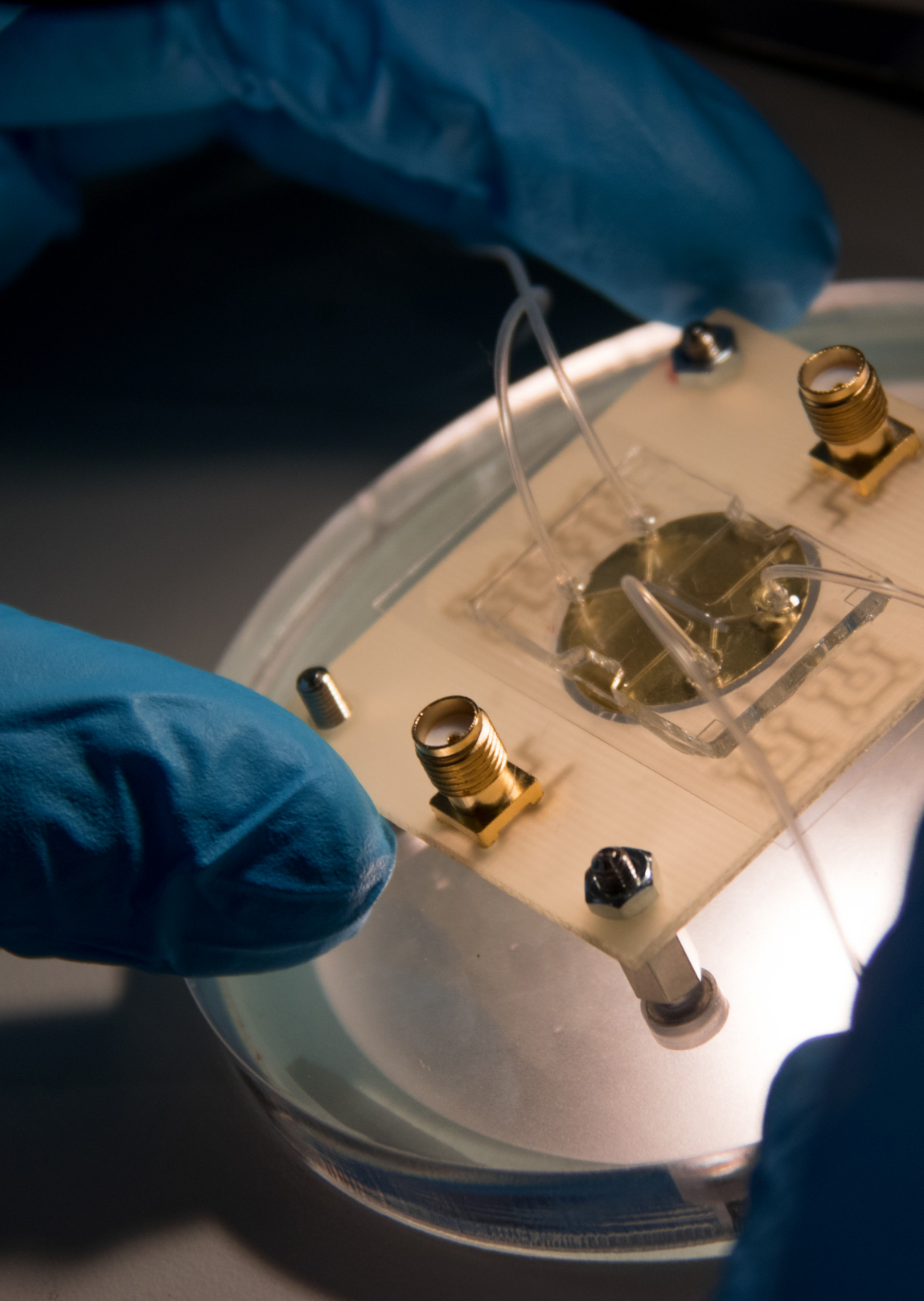

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